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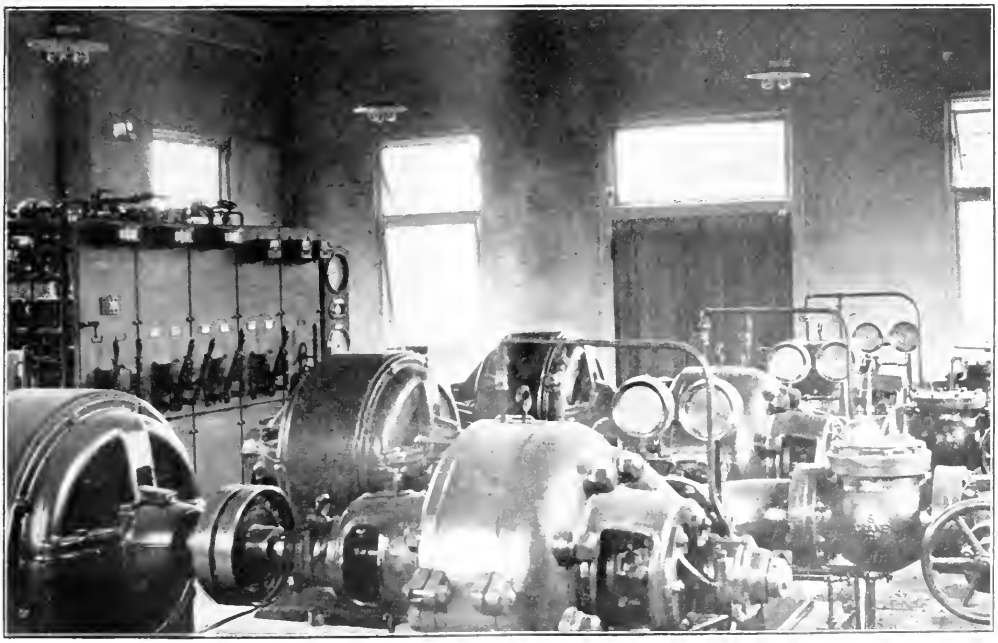
A MOTOR DRIVEN CITY PUMPING PLANT

BY GASKELL S. JACOBS.

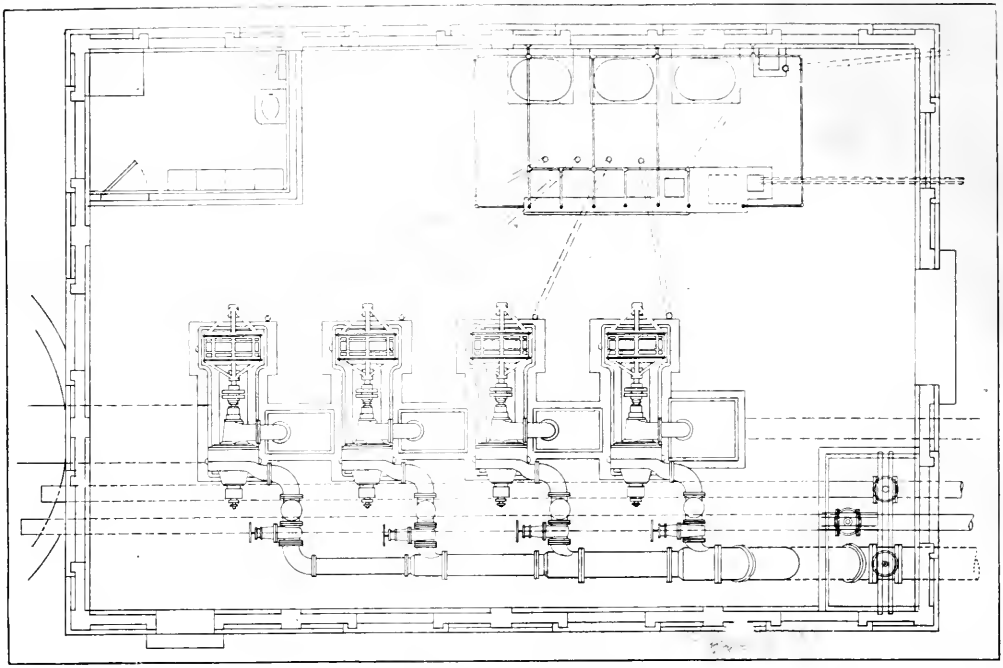
A notable installation of electrically driven turbine pumps has recently been made at the new Diamond pumping plant of the Peoples Water Company at Fortieth and Diamond streets, Oakland.



Interior of Diamond Pumping Plant of Peoples Water Company

In 1907, to meet the demands of water supply in the rapidly growing districts of North Oakland and Berkeley and to supplement the Berkeley supplies, a steam driven reciprocating pumping plant of about six million gallons daily capacity was installed in this locality. This temporary plant showing considerable deterioration and the requirement of the district being more definitely established, it was decided to abandon and dismantle the steam plant, and install a permanent booster plant in its place. Satisfactory arrangements for a dependable supply of electric power having been made at a low price, a consideration of the low first cost of an electric plant, its reduced attendance charges, maintenance and depreciation resulted in the decision to install an electrically operated station. The subsequent performance and reduced operating costs of the plant, which has been running since June 1, 1911, have confirmed the wisdom of this decision.

The plant is located on the east side of Diamond street, south of Fortieth, opposite the old steam station, at an elevation of about 83 ft. The plant is housed in an ample, well-lighted building 30x44 ft. in plan with walls 18 ft. high of reinforced concrete, with a steel roof structure and concrete slab roof and floors. The walls are finished inside and out with cement plaster. At night the station is lighted by six clusters



Plan of Diamond Pumping Plant

of three 60-watt Mazda lamps each. A small room containing lockers, stores, and conveniences is partitioned off at a rear corner of the building.

The present installation provides for a pumping capacity of six million gallons daily under a variable head of from 220 to 280 ft., in three units, with space for a fourth similar unit, making an ultimate capacity of eight million gallons per day, thus insuring both flexibility and reserve, with provision for future increase in consumption. The supply is taken from a 16-in. main on Fortieth street into which are connected the ends of the network of the distributing pipes of the City of Oakland, and is carried into the station through two 10-in. intake pipes with regulating gates operated inside the building. The discharge main, 16 in. in diameter and over 13,000 ft. in length, runs out Broadway, College avenue and Webster street to Claremont reservoir, situated at an elevation of 295 ft., supplying the intermediate sections of Oakland and Berkeley through branch mains and, in addition, a part of the Linda Vista district. At night the pressure is high, the water flowing directly to the reservoir; during the day, however, the pressure at the pumps is reduced, due to the use of water along the line, the supply being then furnished from both ends of the main. The pumps respond easily to these variations in pressure and delivery and are so designed as to keep approximately constant full load on the motors without a reduction in efficiency.

The water flows into a covered sump 20 ft. in diameter and 7 ft. deep at the rear of the building with an electrically operated high and low water alarm, thence through a tunnel under the building, in which are the pits for the suction pipes, which drop through openings in the floor above. A 12-in. tile drain leading to a nearby storm sewer carries the overflow from the tunnel. There are three 8-in., 2-stage, horizontal turbine pumps running at a speed of 1780 r.p.m., direct connected by flexible leather link couplings to 440-volt, 3-phase induction motors rated 150 h.p. each. The pumps are fitted with ring oiling bearings, water sealed stuffing boxes, enclosed non-overloading runners, renewable diffusion vanes, and adjustable thrust balance. They are primed by direct pressure from the mains, the suctions being provided with foot valves. The discharge pressure varies from 95 to 120 lb. per sq. in., and the suction lift averages 9 ft. with a delivery of 1800 to 1400 gallons per minute, over which range a pump efficiency of better than 70 per cent is maintained.

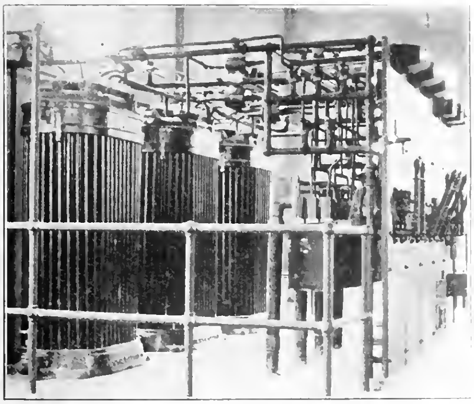
The induction motors have squirrel cage windings, enclosed frames, with ventilating fan blades attached to rotor. Their normal full load power factor is 96 per cent, and under the steady full load show a high efficiency. They are mounted on the extended base plates of the pumps.

The operation of the station is noticeable for its smoothness, uniformity, and absence of all shock and disturbance in the discharge main. Each pump discharge is fitted with check and gate valves and long sweep fittings connect them to the main 16-in. discharge header. These gates are not manipulated while running, the pumps automatically responding to all changes of pressure and delivery. The intakes and discharge mains are regulated from a group of valves in a pit at the front of the building and operated from wheel stands above. In full view of the operator at

the wheels, are placed the indicating gauges, mounted on a slate panel.

The power demand of the station is uniform and continuous throughout the day and night, and is supplied from a 3-phase, 4-wire, 4000-volt line from the Temescal substation of the Oakland Gas, Light & Heat Company. It is connected through an underground service and an 11,000-volt oil station switch to a bank of three 125-kw. transformers, placed within the building and stepping down to 440 volts for the motors. These transformers are supplied with 220-volt taps for starting the motors, thus obviating the use of starting compensators.

The switchboard consists of five slate panels, one for the station switch and motors, four remaining for triple pole, double throw oil switches. These switches are provided with overload and no voltage releases and are interlocked, being used to throw over the motors from the starting to running voltage. All the bus bars, wiring, current and potential transformers for meters, high tension feeders and switchboard panels are carried on a pipe frame, which also serves as a railing enclosure for the electrical apparatus. All conduits for wires, supplying light and power are concealed in the walls and floor of the building. All small water pipes for station use and pump priming are buried in the concrete floor, and the drains from the pumps discharge



Switchboard and Transformers.

into a vitrified conduit under the floor connecting with the overflow. The motor leads are 3-conductor lead-covered cables running in conduits under the floor from the switches back of the switchboard to the motor terminals, both ends being provided with porcelain outlet bushings.

To measure, indicate and register the delivery from the pumps, a 16x8 in. Venturi meter is set in the main discharge line just without the building, and the pressure pipes run to an automatic indicator and recorder at the end of the main switchboard. Each pump is equipped with pressure and vacuum gauges. The station output is measured by recording pressure gauges, and the recording meter, the switchboard instruments account for all the power consumed, so that the performance of the station at all times is closely known.

The pumps were furnished by the Byron Jackson Iron Works. The switches, switchboard, motors, transformers, and other electrical equipment by the General Electric Company, and the complete design and plans of the station, the pumping and electrical equipment, construction of the building, and installation of the machinery was in charge of the writer as assistant engineer of the Peoples Water Company.

INDUSTRIAL LIGHTING.

The National Association of Manufacturers' committee on ventilation, heat and light find that the effect of varying character of artificial light on the quantity and quality of product produced may be and very often is very great and, consequently, affects the cost of production to a very considerable extent; and feels that it is a matter of ordinary observation to those at all expert in the question of artificial lighting that factory lighting, generally speaking, is very far from what it ought to be. The following statement is a brief summary of the principal defects which are ordinarily to be found.

In very many cases there is insufficient illumination. This condition, however, is rapidly improving as the result of the advent of lamps of various kinds of much higher efficiency than anything that has been available in the past. It is a fact, however, that in a great many cases where the absolute amount of illumination is sufficient, the light is nevertheless exceedingly unsatisfactory for various reasons. If the light falls on the work from the wrong direction, not only is there great liability that awkward shadows of the machinery or of the operative's body will interfere with the work, but in addition if light is reflected from polished portions of the machinery or from the work itself directly into the eyes of the operative, the results will be anything but satisfactory. Failure of light to come in the right direction is often distressing to the eyesight and also, in addition, since it may cause the operative to work in an unnatural position, it may result in unnecessary bodily fatigue as well. Such unfortunate results are often obtained if an attempt is made to light a workroom with too few sources of light. Under these conditions, although some operatives may receive a satisfactory light, others are extremely likely to get the light in the wrong direction, with the unsatisfactory results above enumerated.

Another very common defect in factory lighting is the exposure of the eyes of the workers to the direct beams of very brilliant lamps. The use of bare incandescent lamps is almost invariably not only insufficient, but also dangerous. Generally, however, there is no difficulty in avoiding this trouble if proper care is taken.

Still another defect often seen is either too great or too little contrast in the illumination of rooms. The former of these is by far the most common and as an example might be given work on sewing machines, where individual lamps with opaque reflectors are supplied which brilliantly illuminate the machines, but leave the rest of the room in comparative darkness.

METHODS OF CALCULATING ILLUMINATION.[1]

BY L. S. TWOMEY.

In taking up the subject of illumination calculations, it is first necessary to obtain a clear conception of certain fundamental principles, definitions and units. Let us consider a symmetrical light source at the center of a sphere. The total flux of light, which is measured in lumens, flowing away from this source, we will designate as F. The flux per unit of solid angle is the intensity I and is the measure of the candle power of the source. From this it is seen that for a point source, candle power is independent of distance from the source, as the same flux is within the cone at all distances.

The luminous flux falling on the interior of the sphere produces the illumination E, which may be defined as the quantity of flux per unit area of the surface illuminated. Hence $E = \frac{F}{4\pi r^2}$. If our light source has an intensity of 1 candle in all directions, the amount of flux contained in each unit solid angle will be one lumen, and if the sphere be considered as having a radius of 1 foot, it follows that each square foot of its surface receives one lumen from the source, and by definition, the illumination produced is one foot candle. The total flux flowing away from the source is one spherical candle, and since there are 4π units of solid angle in the sphere, 1 spherical candle $= 4\pi$ lumens.

Since the area subtended by one unit of solid angle varies directly with the square of the radius, and for a given candle power the flux within the angle remains constant, it follows that the flux falling on one unit of area, together with the illumination, varies inversely with the square of the radius. This is known as the law of inverse squares.

In practical lighting units, the distribution of light is symmetrical only about one axis. It is therefore necessary that we have some method of ascertaining the total light flux and its distribution about the source. It is customary to obtain the polar distribution curve of light about the source, and then to calculate the total flux by one of several different methods.

The polar distribution curve is usually obtained by measuring the candle power at a number of angular positions in a plane containing the axis of symmetry. The unit is generally rotated about this axis while the readings are being taken, in order to equalize any possible lack of symmetry. Thus it will be seen that each reading is the candle power at the center of a zone of the sphere. (See Fig. 1). Several such distribution curves are shown in Fig. 15, 16 and 17.

It must be remembered that the total number of lumens emitted by the source is not in any way proportional to the area of the distribution curve. A light source of uniform candle power in all directions, radiates a greater flux in a zone near the horizontal than it does in an equiangular zone near the vertical. This is readily seen, because the area of the zone nearer the horizontal is greater than that of the zone nearer the vertical.

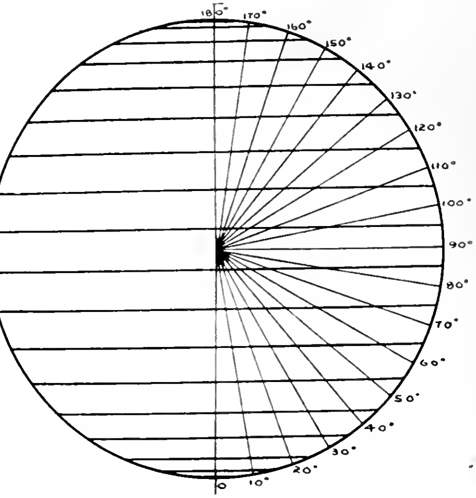


Fig. 1.

There are several methods of obtaining the total flux from the distribution curve, including the Rousseau diagram, the Kennelly diagram, and the Fluxolite diagram.

Rousseau Diagram.

The Rousseau diagram is the oldest of these methods, and is shown in Fig. 2. The distribution curve is plotted on ordinary polar co-ordinate paper at the left, while the Rousseau diagram is shown at the right.

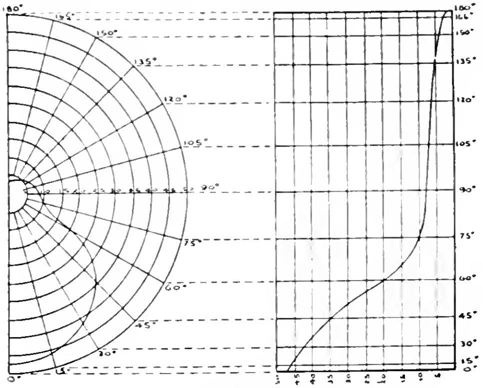


Fig. 2. Rosseau Diagram.

This sheet is laid out by projecting the various polar radii to form the horizontal lines, the vertical lines being to a uniform scale, and representing candle power. The candle power readings are plotted on this sheet at their respective angular positions, and the average ordinate of the curve is proportional to the total flux emitted by the source. Similarly the average ordinate of the curve for any zone is propor-

[1] Paper presented before San Francisco Section A. I. E. E., June 23, 1911.

tional to the flux emitted in that zone. In practice it is customary to measure the area of the curve with a planimeter, and then from this area and the scale to which the curve is plotted, to obtain the mean spherical candle power of the unit. Multiplying this value by 4π gives the result in lumens. If the Rousseau diagram be divided into twelve areas of equal height, the ordinates at the centers of these zones may be read, and their sum, divided by twelve will give the approximate average ordinate of the diagram without the use of a planimeter.

This forms the basis of the method of obtaining spherical intensity by direct average. (See Fig. 3).

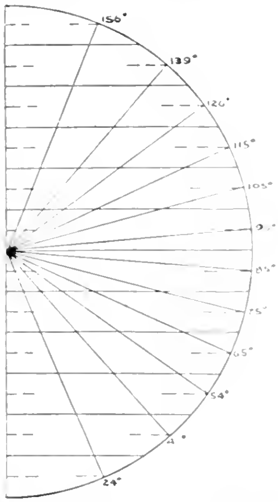


Fig. 3. Spherical Intensity by Direct Average.

The various radii are located by projecting the [illegible] of the zones of equal height onto the circle [illegible] gram can be drawn on transparent celluloid [illegible] over a distribution curve, and the candle power [illegible] read at the intersection of each radius with the [illegible] bution curve. These readings will be the same as [illegible] obtainèd at the centers of the zones of equal [illegible] on the Rousseau diagram, and, on being averaged [illegible] be numerically equal to the M. S. C. P. of the curve.

Based on the Rousseau diagram is a series of [illegible] stants which may be used for obtaining an approxi[illegible] mate value of the mean spherical candle power [illegible]

Angles at which C.P. is read.	M.S.C.P Constants	M.[illegible]
0 - 10 - 170 - 180	.0038	[illegible]
10 - 20 - 160 - 170	.0113	[illegible]
20 - 30 - 150 - 160	.0184	[illegible]
30 - 40 - 140 - 150	.0250	[illegible]
40 - 50 - 130 - 140	.0208	[illegible]
50 - 60 - 120 - 130	.0357	[illegible]
60 - 70 - 110 - 120	.0395	[illegible]
70 - 80 - 100 - 110	.0421	[illegible]
80 - 90 - 90 - 100	.0434	[illegible]

Fig. 4. Multipliers for Obtaining M. S. C. P. and M. H. S. C. P. from Candle Power Reading.

hemispherical candle power. (See Fig. 4). The approximation lies only in the assumption that the curve is a straight line between readings. This assumption is made, however, in almost all practical work. To use these constants it is only necessary to add the four candle power readings at the various angles denoted in each line of the first column, multiplying the result by the constant given in the second column. After proceeding through the whole distribution curve in this manner, the sum of the products will be numerically equal to the mean spherical candle power of the curve.

Similarly, to obtain either the upper or lower mean hemispherical candle power, add the two candle power readings at the angles denoted in each line of the first column, using the upper or lower hemispherical readings as desired, and multiply the sum by the constant in the third column. The sum of these products will be numerically equal to the mean hemispherical candle power of the curve.

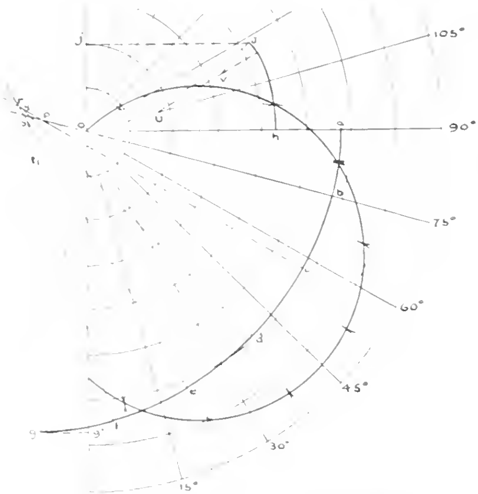


Fig. 5. Construction of Kennelly Diagram.

Kennelly Diagram.

The Kennelly diagram has the advantage of requiring only a protracter and pair of compasses for its construction. (See Fig. 5.) The construction is best shown by means of an example [illegible] the distribution curve shown in the figure [illegible] as a center and the radius equal to the mid candle power of the 75-90 degree zone describe the arc ab, and the angle between Oa and Ob being 15 degrees. Then with a radius equal to the mid candle power of the 60-75 degree zone and center P on Ob describe a second arc bc, the angle between Pb and Pc being 15 degrees. Then with a radius equal to the mid candle power of the 45-60 degrees, and a center [illegible] on Pc, describe the third arc, the angle between [illegible] being 15 degrees. This process is continued throughout the lower hemisphere, and if the diagram is accurately constructed, the line tg will be vertical. The procedure in the upper hemisphere is similar. Project the points J and g on the vertical, and one-half the distance J′g′ to scale of the curve is numerically equal to the mean spherical candle power, the length OJ′ the mean upper hemispherical candle power and the length Og′ the mean lower hemispherical candle power.

Fluxolite Diagram.

The Fluxolite diagram is one of the most convenient methods of determining the flux in lumens in any zone or for the whole distribution curve. (See Fig. 6). It can be assumed without material error, that the flux in any zone ϕ = area of zone x mid candle power of zone. Since the areas of equiangular zones of a sphere are proportional to the sines of their bisecting angles, measured from the axis of the zones, $\phi = K I \sin a$.

Where ϕ = flux in zone, a = bisecting angle of zone, I = Mid candle power of zone, K = constant of proportionality.

But I sin a = horizontal projection of mid candle power.

Therefore, ϕ = K horizontal projection of mid candle power.

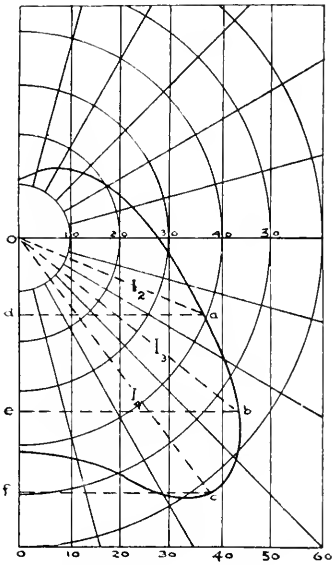


Fig. 6. Fluxolite Diagram.

To evaluate K. Area of zone, $A = \int_{a_1}^{a} 2\pi R \sin a \, da = 2\pi R \, [\cos a_2 - \cos a_1]$.

But since A = K sin a (bisecting angle)

$$\text{and } a = a_1 + \frac{a_2 - a_1}{2}$$

$$K \sin\left(a + \frac{a_2 - a_1}{2}\right) = 2\pi R \, [\cos a_2 - \cos a_1].$$

$$\text{Solving for K.} \quad K = 2\pi R \frac{\cos a_1 - \cos a_2}{\sin\left(a_1 + \frac{a_2 - a_1}{2}\right)}$$

Substituting the various values for a_1 and a_2 in the above equation we obtain the values of K for zones of various angular widths.

To use these constants it is only necessary to measure, to scale of curve, the horizontal projections of the mid candle powers of the various zones, (See

Width of zones	Constants
5 degrees	0.548
10 degrees	1.098
15 degrees	1.64
20 degrees	2.18
25 degrees	2.72
30 degrees	3.25
35 degrees	3.77
40 degrees	4.3
45 degrees	4.8

Fig. 7. Constants for Use With Horizontal Projections of Mid Candle Power of Equiangular Zones.

Fig. 7), and to multiply the sum of the projections by the proper value of K, depending on the angular width of the zones. The result will be given directly in lumens, which may be reduced to mean spherical candles by dividing by 4π. Similarly the mean hemispherical candle power may be obtained by dividing the flux in the desired hemisphere by 2π.

Referring to the values of K given in the table, we see that the value for 10 degree zones is 1.098. If the distribution curve be plotted on polar co-ordinate paper so dimensioned that 1.098 inches equals some multiple of the candle power, the horizontal projections may be measured directly in inches and on multiplying the sum of the projections by the multiple of the candle power, the result will be the flux in lumens.

Mr. Norman Macbeth has designed a polar flux scale which may be used to measure the horizontal projections, giving the result directly in lumens. It is necessary, however, to use this scale only with the particular polar co-ordinate paper for which it was designed.

We have taken up in detail all of the more common methods of obtaining the amount of light available for illuminating purposes from a given lighting unit and may now proceed to the various methods of calculating the illumination.

In order to compare the illumination produced by different installations, it is necessary to select some plane on which to measure the intensity. It is common practice to select a horizontal plane at a height determined by the purpose for which the illumination is to be used. This "working plane" as it is called, would be at the level of the desk tops in offices and at the level of counter tops in stores.

Point by Point Method.

One of the methods in use, is known as the point by point method, (See Fig. 8). This method takes no

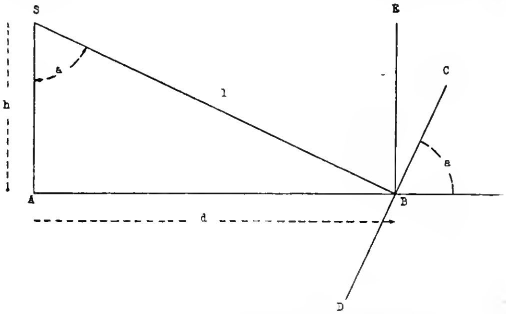


Fig. 8. Point By Point Method.

account of wall and ceiling reflection, but is nevertheless useful in determining the comparative uniformity of illumination from different sources and for determining heights and spacing of units.

Referring to the figure, let a = angle which light rays make with vertical; I_a = candle power in direction SB at angle a from vertical; E_n = Illumination on plane CD normal to Sb; E_h = Illumination on horizontal plane AB; d = distance from point beneath source to point where illumination value is desired; h = height of lamp above horizontal plane; I = distance from source to point B. Then the illumination at point B on plane cD,

$$E_n = \frac{I_a}{I^2}$$

Since

$$I = \frac{h}{\cos a}$$

$$E_n = \frac{I_a \cos^2 a}{h^2}$$

Also

$$E_h = E_n \cos a$$

Therefore

$$E_h = \frac{I \cos^3 a}{h^2}$$

The value of I_a is found from the distribution curve of the source under discussion and the value of a may be computed from the values of h and d. To facilitate this work various tables (See Fig. 9), have been computed, giving the values of the angle a for various values of h and d, together with the illumination produced at the corresponding points on the horizontal plane by a one candle power source. To use this table it is only necessary to look up the value of a for the assumed values of h and d, together with illumination produced at the point by the one candle power source. Then from the distribution curve find the candle power at the angle a and multiply this by the illumination from the one candle power source.

The results calculated in the above manner may be represented graphically as shown in Fig. 10, where

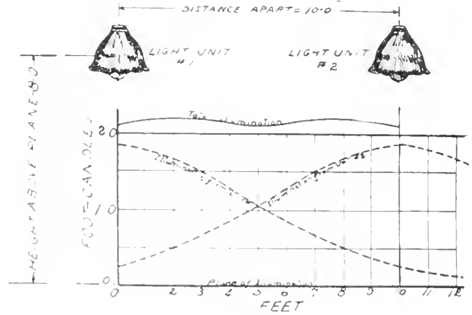


Fig. 10.

the abscissae represent various horizontal distances from the source, and the ordinates represent the corresponding illumination in foot candles.

The first step in designing a system of illumination for a given room is to select the intensity in foot candles. The intensity varies with different classes of service and considerable care should be used in making this assumption. Values are given in Fig. 11 for several common classes of service.

Class of Service	Light Intensity in Foot Candles
Auditoriums (General Illumination)	1 to 3
Theatres " "	1 to 3
Churches " "	2 to 3
Reading Rooms	1 to 3
Residences (General Illumination)	1 to 2
Desk Illumination	2 to 5
Postal Service	2 to 5
Bookkeeping	3 to 5
Stores, (General Illumination)	2 to 5
Stores, Clothing	4 to 7
Drafting	5 to 10
Engraving	5 to 10

Fig. 11.

Intensity of Illumination in Foot-Candles on Horizontal Planes at Points at Various Distances from a Light Source of 1 Candle-Power. Angle Between Light Ray and Line Perpendicular to Plane Illuminated

Horizontal Distance in Feet from Point Directly Under Light Source to Point Where Intensity of Illumination is Desired (columns); Height of Light Source in Feet Above Plane Illuminated (rows)

Height	0	1	2	3	4	5	6	7	8	9	10
4	0° 0' 06250	14° 2' 05707	26° 34' 04472	36° 52' 03200	45° 0' 02210	51° 20' 01524	56° 19' [illegible]	[illegible]	[illegible]	[illegible]	[illegible] 12' 00320
5	0° 0' 04000	11° 19' 03771	21° 48' 03202	30° 58' [illegible]	38° 40' 01904	45° 0' 01414	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	0° 0' 02778	9° 28' 02673	18° 26' 02372	26° 34' 01987	33° 42' 01600	39° 48' 01260	45° 0' [illegible]	49° 24' [illegible]	[illegible]	[illegible]	[illegible]
7	0° 0' 02041	8° 8' 01980	15° 57' 01814	23° 12' [illegible]	29° 45' [illegible]	[illegible]	40° 37' [illegible]	45° 0' 00722	[illegible]	[illegible]	[illegible]
8	0° 0' 01563	7° 8' 01527	14° 2' 01427	20° 33' [illegible]	26° 34' 01118	[illegible]	[illegible] 00800	41° 10' [illegible]	[illegible]	[illegible]	[illegible]
9	0° 0' 01235	6° 20' .01212	12° 32' .01118	18° 26' 01054	23° 57' [illegible]	[illegible]	[illegible] 42' 00711	[illegible]	[illegible]	[illegible]	[illegible]
10	0° 0' 01000	5° 43' .00985	11° 19' 00943	16° 42' 00879	21° 48' 00801	[illegible] 00716	30° 58' 00631	[illegible]	[illegible]	[illegible]	[illegible]
11	0° 0' 00826	5° 12' .00816	10° 18' .00787	15° 15' 00742	19° 59' 00686	24° 27' [illegible]	28° 37' [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	0° 0' 00694	4° 46' 00687	9° 28' .00668	14° 2' 00634	18° 26' [illegible]	22° 37' 00546	26° 34' 00497	[illegible] 00448	[illegible]	[illegible]	[illegible]
13	0° 0' 00592	4° 24' .00587	8° 45' .00571	13° 0' 00547	17° 6' 00517	[illegible] 00481	24° 46' 00447	28° 18' 00404	[illegible]	[illegible]	[illegible]
14	0° 0' 00510	4° 5' .00506	8° 8' .00495	12° 6' 00477	15° 57' 00454	[illegible] 00426	[illegible] 00396	[illegible]	[illegible]	[illegible]	[illegible]
15	0° 0' 00444	3° 49' .00442	7° 36' .00433	11° 19' 00419	14° 56' .00401	18° 26' 00380	21° 48' [illegible]	[illegible] 00331	[illegible] 00305	[illegible]	[illegible]
16	0° 0' 00391	3° 35' 00388	7° 8' .00382	10° 37' 00371	14° 2' 00357	[illegible]	[illegible] 00321	[illegible] 00300	26° 34' [illegible]	[illegible]	[illegible]
17	0° 0' 00346	3° 22' 00344	6° 42' 00339	10° 0' .00331	13° 15' 00319	[illegible] 00306	19° 26' 00290	[illegible] 00274	[illegible]	[illegible]	[illegible]
18	0° 0' 00309	3° 11' .00307	6° 20' 00303	9° 28' 00297	12° 32' 00287	[illegible]	18° 26' 00264	21° 14' 00250	[illegible]	[illegible]	[illegible]
19	0° 0' 00277	3° 1' 00276	6° 0' 00273	8° 58' .00267	11° 53' 00260	[illegible] 00251	17° 31' 00240	20° 13' 00229	[illegible] 00217	[illegible]	[illegible]
20	0° 0' 00250	2° 52' 00249	5° 43' 00246	8° 32' .00242	11° 19' 00236	14° 2' [illegible]	16° 42' 00219	19° 17' 00210	21° 48' 00200	24° 14' [illegible]	[illegible]

Height	11	12	13	14	15	16	17	18	19	20
4	70° 1' 00249	[illegible]	[illegible]	[illegible] 00130	75° 4' 00107	[illegible]	76° 46' 00075	[illegible]	[illegible]	78° 42' 00047
5	65° 34' [illegible]	[illegible]	68° [illegible]	70° 21' [illegible]	71° 34' 00126	[illegible]	[illegible]	[illegible] 00077	[illegible] 00066	[illegible] 00057
6	61° 23' [illegible]	63° 26' 00249	[illegible]	[illegible]	[illegible] 00142	[illegible]	[illegible]	[illegible]	[illegible] 00076	[illegible]
7	57° 31' 00316	59° 45' 00262	61° 41' [illegible]	[illegible]	64° [illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00084	[illegible]
8	[illegible] 00318	[illegible] 19' 00267	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67° 10' 00091	[illegible]
9	50° 42' 00314	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00146	[illegible]	[illegible]	64° 40' [illegible]	[illegible] 46' [illegible]
10	47° 43' 00307	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	45° 0' 00292	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00117	[illegible] 00104	[illegible]
12	42° 31' 00278	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00106	[illegible] 00094
13	40° 14' 00263	42° 44' [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00119	[illegible] 00106	56° 59' 00096
14	38° 9' 00248	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00107	55° 1' 00096
15	36° 15' 00233	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00117	51° 43' 00106	53° 8' .00096
16	34° 30' 00219	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 00105	51° 20' [illegible]
17	32° 54' .00205	[illegible]	[illegible] 00174	[illegible]	[illegible]	[illegible]	[illegible]	46° [illegible]	48° 11' 00103	49° 39' 00094
18	31° 26' 00192	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45° 0' [illegible]	46° 33' 00100	48° 0' 00092
19	30° 4' 00180	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 27' 00106	[illegible] 0' 00098	46° 29' 00090
20	28° 49' .00168	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40° 22' 00111	41° 59' [illegible]	43° 32' 00095	45° 0' 00088

Fig. 9.

In this connection Fechner's law of vision is of great importance. This law is briefly as follows:

The sensations produced on the optic nerves vary approximately as the logarithms of the values of the stimuli producing the sensations. In other words, the same change in sensation is produced by increasing from 2 to 4 foot candles as by increasing from 4 to 8, from 6 to 12 and so on. After the desired illumination value has been assumed, there are several methods of procedure, all based on the results of tests of the equipment, and the class of room under consideration.

The total number of effective lumens required is obtained by multiplying the area to be lighted in square ft., by the assumed foot candle value.

Due to the absorption of the reflectors, walls, etc., only a portion of the lumens emitted by the source are effective on the working plane, so that it is necessary to have data on previous tests in order to calculate the total wattage required. Fig 12 shows the effective lumens per watt for various lamps equipped with Holophane reflectors in rooms having either light or dark walls.

Lamps	Reflectors	Walls	Constant
Mazda	Clear Holophane	Light	5.
Mazda	Clear Holophane	Dark	4
Mazda	Enameled or satin fin.	Light	4.3
Mazda	Enameled or satin fin.	Dark	3.4
Gem	Clear Holophane	Light	2.2
Gem	Clear Holophane	Dark	1.8
3.1 Watt Carbon	Clear Holophane	Light	1.8
3.1 Watt Carbon	Clear Holophane	Dark	1.5

Fig. 12.

The total watts required is found by dividing the total number of effective lumens required by the effective lumens per watt constant.

$$\text{watts} = \frac{(\text{sq. ft. x foot candles}) = \text{effective lumens}}{\text{effective lumens per watt constant.}}$$

The above method is open to two serious objections; first the wide limits over which the wall conditions are defined, and second, the fact that the lumens per watt constants are based on a definite watts per candle of the lamps. As the watts per candle values have been changed from time to time, this is a rather serious objection to the method, as it requires a new set of constants for each change.

If, however, the constants be based only on the percentage of the total generated lumens which is effective on the working plane under given conditions, changes in the lamp efficiency will not affect the values of the constants. A table of such illumination constants is given in Fig. 13.

Lamp	Equipment.	Ceiling.	Walls.	Constant.
Mazda	Clear Holophane Reflector	Light	Light	.625
Mazda	Clear Holophane Reflector	Light	Dark	.575
Mazda	Clear Holophane Reflector	Dark	Dark	.50
Gem	Clear Holophane Reflector	Light	Light	.57
Gem	Clear Holophane Reflector	Light	Dark	.45
Gem	Clear Holophane Reflector	Dark	Dark	.38
3.1 watt car.	Clear Holophane Reflector	Light	Light	.57
3.1 watt car.	Clear Holophane Reflector	Light	Dark	.45

Fig. 13.

The method of applying these constants is as follows: Multiply the area to be lighted, expressed in square feet, by the desired foot candle intensity. This gives the effective lumens required, which should be divided by the proper illumination constant. The result is the total lumens required to produce the desired illumination. By referring to a table of total lumens given out by each of the various sizes and classes of lamps, (See Fig. 14), it is a simple matter

TOTAL LUMENS GIVEN BY

Rated Watts	MAZDA 100-125 volts	MAZDA 200-250 volts	TANTALUM 100-125 volts	TANTALUM 200-250 volts	GEM 100-125 volts	CARBON 100-125 volts	CARBON 200-250 volts
10						21.2	
20						50.3	
25	187.		126.			83.6	
30						96.4	
35							84.
40	319.		221.		162.		
45		302.					
50			277.	252.	207.	174.	
60	498.	402.			249.	208.	171,
80			443.	398.	337.		
100	830.	671.			419.	349.	
120						419.	341,
150	1245.	1006.					
250	2168.	1677.					
400	3470.						
500	4335.	4035.					

Fig. 11

to determine the necessary wattage and the size and number of lamps. Changes in the watts per candle of the lamps necessitate only a revision of the lumens table.

All that now remains is to distribute the lamps according to the proper spacing and height. This is a matter largely governed by experience, although several manufacturers offer valuable suggestions and rules for installing their products. In the absence of these rules it is necessary to use something of a "cut and try" method, checking up each proposed spacing for uniformity by means of the point by point method.

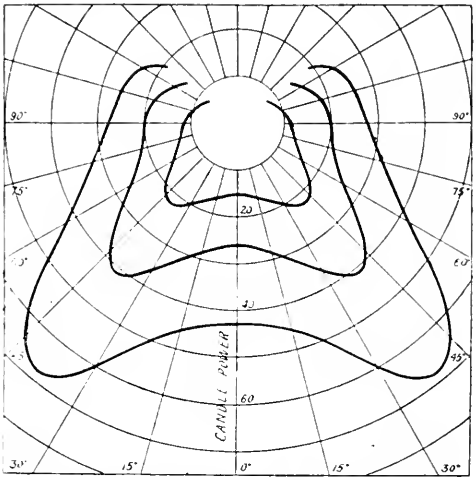


Fig. 15. Characteristic Curves "MAZDA" 35, 40 and 60-watt, 100-125-volt Bowl-Frosted Lamps with Extensive Reflectors.

It is extremely difficult to lay down many definite rules for the spacing of outlets, as this is often determined by the architectural requirements. The spacing of outlets, the height of units above the floor and the type of reflector used are all interdependent, so that each case must be worked out individually.

One requirement should always be observed however; the space to be illuminated should be divided as nearly as possible into squares and one outlet placed at the center of each square.

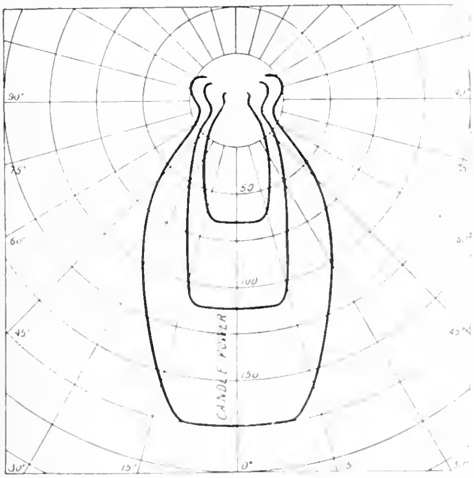


Fig. 16. Characteristic Curves "MAZDA" 25, 40 and 60-watt, 100-125-volt Bowl Frosted Lamps.

The Holophane line of high efficiency reflectors affords perhaps the best example of securing correct heights and spacing by means of the manufacturers' rules. These reflectors are made in three general types of each size, known as extensive, intensive, and focusing. As their names indicate, the extensive type (Fig. 15) gives the broadest distribution of light, the maximum occurring at 45 or 50 degrees from the vertical;

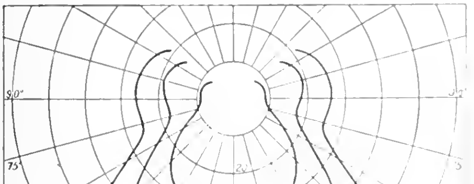


Fig. 17. Characteristic Curves "MAZDA" 25, 40 and 60-watt, 100-125-volt Bowl-Frosted Lamps with Intensive Reflectors.

the focusing type (Fig. 16) gives a maximum candle power out to about 10 degrees, while the intensive type (Fig. 17) comes in between the extensive and the focusing, its maximum occurring out to about 40 degrees. As the uniformity of illumination depends upon the ratio of spacing to height above the plane of illumination, the correct values of these ratios have been worked out and are as follows:

Extensive Type: Height = approximately 1/2 average distance apart of outlets.

Intensive type: Height = approximately 4/5 average distance apart of outlets.

Focusing type: Height = approximately 1 1/3 average distance apart of outlets.

It will generally be found that it is a necessary use the "cut and try" method to determine which type of reflector is best suited for a given problem, in order to conform with the various requirements of architecture, appearance and possible spacing of outlets.

COMPULSORY WIRELESS FOR VESSELS.

Effective July 1, 1911, all ocean-going vessels carrying more than fifty passengers must be equipped with wireless telegraph apparatus capable of transmitting messages at least 100 miles, according to an act of Congress passed June 24, 1910. The operator must possess a government certificate given after passing an examination at one of the navy yards or naval stations. After January 1, 1912, storage batteries or other auxiliary must be provided in case of any accident to the dynamo.

ON THE CONTROL OF SURGES IN WATER CONDUITS.[1]

BY W. F. DURAND.

The usual treatment of the problem of the surge chamber presupposes a cylindrical form. Certain cases may arise in which a flaring or funnel-shaped form may rather be preferred. In any case the differential equations which indicate the movement of the water do not admit of direct mathematical solution. In consequence, various indirect and approximate methods have been devised. In all such, however, the point of departure has been an assured size of chamber and a consequent determination of the resulting movement of the water. In the present paper the order is reversed. A program is imposed on the water and a surge chamber is found suitable for the realization of these imposed conditions. Taken in this order, the equations by the use of methods of approximate integration and differentiation admit of direct solution without trial and error adjustment. This method is described and illustrated in operative detail, with appendices giving the necessary mathematical discussion.

The relations between the characteristics of the acceleration curve for the water and the resulting form and dimensions of the chamber are discussed in detail and methods are developed for the rapid derivation of a series of chambers from a single type acceleration curve; also, for the determination of a chamber of such form and size as shall produce a non-oscillatory movement of the water in the chamber. Illustrative cases with graphical representation of the quantities involved are given in Appendix No. 3.

[1] Abstract of paper presented at San Francisco Meeting American Society of Mechanical Engineers, June 28, 1911.

WORKMAN'S CONPENSATION ACT FOR WASHINGTON.

Adequate protection for employer and employee, increased safety of industrial operations, sure and certain relief for workers injured at extra hazardous occupations, and their families and dependents, elimination of litigation and consequent saving of retainer's fees and court expenses and regulation by state police powers of dangerous trades and occupations, are some of the advantages claimed for the workman's compensation act, which will become effective in Washington on October 1, 1911.

The theory of the act, which was adopted by the last Legislature, is stated in these words: "The welfare of the state depends on its industries and even more upon the welfare of its wage-earners."

The new law applies to all factories, mills and workshops where machinery is used and foundries, quarries, mines, smelters, powder works, breweries, elevators, docks, dredges, laundries, printing, engineering, logging, lumbering, ship-building, railroad and general building operations, street and interurban railroads, electrical, power and heating plants and steamboats.

One hundred and fifty thousand dollars has been appropriated by the state to bear the expense of administering the law, and Governor Marion E. Hay has appointed a commission to have full charge of the industrial insurance work, including the collection of premiums and the adjustment and settlement of claims. The commission, which is composed of George A. Lee of Spokane, representing the legal profession, chairman; C. A. Pratt of Tacoma, for the manufacturers and employers, and J. H. Wallace of Seattle, for the workingmen, has power to create new classes and establish new rates.

The law provides that each of the industries shall contribute a certain percentage of its pay-roll to an accident fund, from which various sums are paid out for total or part disability or on death to the family and dependents of the injured workman, the expense of handling the fund being borne by the State. Injured workmen, their families or dependents, cannot recover by law except where the injury is caused by the intent of the employer, in which case the workman or his family may recover not only the sums due under this act, but may sue for any excess of damage over those amounts.

Where a workman is injured because the employer has neglected to observe the safeguards required by law or by the regulations of the department, the employer must pay 50 per cent more than the fixed amounts. Where the workman intentionally injures himself he receives no benefit.

The industries of the state are classified and certain premiums fixed for each class. The employers are required to pay three months' premiums into the state treasury on or before October 1, 1911. After December 31, 1911, monthly payments are required, provided, however, that if any industry has a sufficient amount on deposit with the state to take care of its accidents no further payments shall be required.

Each industry is responsible only for the accidents occurring in that class. It is intended that the accident fund shall be neither more or less than self-supporting. The rates are subject to readjustment, depending on the number of accidents and the need for compensation of injured workmen.

Employers are required to report accidents promptly, and their books, records and pay-rolls must be open for inspection by the commission. Refusal to permit inspection is made a misdemeanor and the employer also is penalized $100 for each offense, to be collected by action in court and paid into the accident fund.

Misrepresentation in his pay-roll makes the employer liable to 10 times the difference between the correct and the wrong figures. If the employer refuses or fails to pay his monthly assessments, a workman injured in his service may sue in the courts with the employer's defenses of "fellow-servant," "assumption of risk" and "contributory negligence" abolished.

No part of the premium can be deducted from the ages of the workman, the violation by the employer of this section of the law being made a gross misdemeanor, punishable by one year in the county jail or by a fine of $1000, or both.

The schedule of payments for various injuries is as follows:

In the event of death, expenses of burial, $75; payments to widow or invalid widower, $20 a month while unmarried, $240 in a lump sum on remarriage of the widow for each surviving child under 16, $5 a month, monthly amount limited to $35; if no widow or widower survives, $10 a month to each child under 16 years. The same rule applies to children who become orphans by death of surviving parent, with monthly limit of $35. Dependents will be paid 50 per cent of the average monthly support formerly received from the deceased workman, limited to $20 a month. Parents of deceased unmarried workmen receive $20 a month up to time deceased would have been 21 years of age.

When totally disabled, loss of both arms or one leg and arm, sight, paralysis or other injury preventing the workman from doing any work, entitles him to $20 a month if unmarried; if supporting wife or invalid husband, $25 a month; if the husband is not an invalid, $15. For each child under 16, an additional $5 a month up to a total of $35. In case of death of the totally disabled workman, the widow or widower received $20 a month until death or remarriage and $5 a month additional for each child under 16. Orphan children receive $10 a month.

When partly disabled by the loss of one foot, leg, hand or arm, eye or fingers, the workman will receive a certain cash lump sum up to $1500. The loss of one arm at the elbow is made the maximum injury and the payment for other injuries is scaled down by the commission. If the injured workman resides or moves out of the State the commission may lump the monthly payments, not to exceed $4000, based on the American mortality table. Any decision of the commission is subject to appeal in the superior courts.

RESPONSIBILITIES OF ELECTRICAL ENGINEERS IN MAKING APPRAISALS.[1]

BY H. M. BYLLESBY

The electrical engineer must recognize [illegible] addition to the multiplicity of duties he has [illegible] upon to discharge, he is now confronted with [illegible] class of responsibilities from which he cannot [illegible]. To these responsibilities he must give the best [illegible] in him of experience, of fair mindedness, of [illegible] and of justice.

In the world at large and particularly [illegible] United States we appear to be in the midst of [illegible] of flux and change. Old methods and old [illegible] are passing away; new methods and new [illegible] demanded. With the marvelous progress of [illegible] ilized world since the last great economic [illegible] changes, it will be a shame if the present crisis [illegible] a solution more rational and with less hard[illegible] destruction than has attended previous [illegible] economic and social crises. Out of [illegible] versies we must endeavor manfully [illegible] a condition of justice to all concerned [illegible] of duty in these matters we must [illegible] be intelligent and not to be found [illegible] ing and honesty between [illegible] porations and the public and [illegible] and corporations. Principal among [illegible] sibilities which are being rapidly [illegible] fession is making appraisals [illegible] of the property of a public service [illegible]

These values, in accordance [illegible] present trend of the times, are [illegible] which or from which are [illegible] which these corporations are [illegible] for service rendered. There is [illegible] place on replacement values, [illegible] preciation values, and intangible [illegible] jority of cases the property to [illegible] a continuing growth or a constant [illegible] inception. Much of the construction [illegible] called upon to value is [illegible] foundations of buildings, [illegible] submerged portions of hydraulic [illegible] systems and gas pipes. In every [illegible] or plants have been built in [illegible] termed a "piecemeal" fashion. [illegible] service corporation has started [illegible] and added to its plant continuously, and [illegible] structure today represents construction [illegible] has been continued from the time [illegible] was created. In meeting [illegible] spirit of the times is demanding [illegible] erly a demand is made by all parties [illegible] versy that absolute and entire frankness and candor pervade the negotiations. [illegible] has been put to the practice of dissimulation [illegible] ery and misrepresentation on the part of the [illegible] the governing body, and the corporation. From [illegible] experience I can state [illegible] and dissimulation and unfair dealing in the [illegible] been fully as great on the part of the public [illegible] governing bodies, if not greater than [illegible] the corporations. Following this proper demand for candor, I desire to call the attention of my fellow members of the American Institute of Electrical Engineers to the painful fact that it is extremely rare for a professional engineer or constructor in any branch of industry, in any branch of construction, to estimate the cost of such construction with accuracy and that the practically uniform experience has been that all such estimates have proved woefully less than the cost of the completed project.

I believe we should be candid and frank on the subject. Every one of us whose duties require him either as a principal or in an auxiliary capacity to be responsible for the furnishing of capital to build any given public service construction or to develop any given enterprise, knows full well from a long and painful experience that unless he provides for indefinite excess charges or leaves some other avenue of escape, the enterprise or construction when finished will be burdened with a floating debt which seldom is of small relative proportion. This debt is the difference between the estimated cost of building the undertaking and the actual cost as developed after the event. I believe there has not been a considerable piece of public service construction in recent years where the finished cost [illegible] has not overrun the estimated cost by a minimum [illegible] of 10 per cent to 15 per cent [illegible] in a majority of cases of a dangerously [illegible] which not infrequently has gone to [illegible] excess [illegible] of 100 per cent. All experienced contractors will [illegible] the statement I have made. The [illegible] comparatively few contractors who finish their career with more [illegible] than they started with, or with more money than they themselves started with and without [illegible] their backers or guarantee companies in the lurch [illegible] an experience of professional loss, the loss on one [illegible] These men have learned [illegible] and today they will only with the greatest [illegible] take a contract [illegible] unforeseeable [illegible] carefully [illegible] given [illegible] of work [illegible] given [illegible] Where they are forced [illegible] is man[illegible] [illegible] for extras at given rates [illegible] the lump work will be [illegible] extras. This is [illegible] thoroughly [illegible] profession.

I shall [illegible] which universal [illegible] A large [illegible] excess [illegible] undertaking may be represented [illegible] collateral [illegible] completed [illegible] in his [illegible] the part of the [illegible] ignorance [illegible] material and proper part [illegible] completed project be[illegible] [illegible] construction. The overrun [illegible] therefore, is [illegible] upon the omission of [illegible] discussion [illegible] values." But no [illegible] matter whether [illegible] the construction

[1] Extract from address [illegible] Chicago, June 27, 1911.

or from forgetfulness of or ignorance of the proper costs under the head of intangible values, the facts remain substantially as I have stated in my premise.

How careful, therefore, how fair minded and liberal should be the point of view of the professional engineer in appraising the value of another man's or another corporation's property for the solemn and serious purpose of having based upon his appraisal the return which that man or that corporation is to be allowed to receive upon the investment. It is unfair that an engineer or appraiser who recognizes at the bar of his own conscience that his own estimates have been uniformly overrun should make his appraisals without taking into consideration and manfully applying to his estimate his own factor of individual inaccuracy, his own personal factor of nearly unfailing underestimating.

If the profits to be allowed public service companies were to be on a broad and liberal basis this feature would be of less importance. The spirit of the times, brought around partly by mistakes, by selfishness, bv unfairness, on the part of all parties to the contract, the tendency of the times, actuated to a degree by certain irresponsible magazine writers, magazines and papers, and by certain politicians, all tend to reduce the return of the public service corporation to a low point. At best it would indicate, allowing the public service corporation after paying its operating expenses and depreciation charges, a distributable sum equivalent to from 7 per cent to a possible 10 per cent upon its reproduction value, the higher percentage being rather hoped for than indicated. It becomes plainly evident, therefore, how grievous a hardship may be worked upon corporations if the appraisal of their property is as much below the real value of their property as the average estimate of the engineer has proven in the past. I think the situation is one of the most momentous which confronts our profession today. A large part, I presume 90 per cent, of the activities of our profession have resulted from the continuing growth and existence and development of public service corporations. If these corporations through under appraisals or drastic regulations are discouraged and cease their active aggressive growth of the past it will be immediately reflected in the lessening demands made for the services of the members of our profession.

Capital is a peculiarly mobile commodity. Capital will flow from one part of the world to another in accordance with the inducements which are offered it. Capital will leave any given field with great speed if it finds that it is receiving an unfair or unjust recompense or other fields offer greater inducements. Without capital, modern enterprise is impossible. The most beneficial use of capital is to have it employed in developing new enterprises, extending existing enterprises which in turn develop and add to the wealth of the communities served. In our extending enterprises we afford profitable employment for increasing population and we ameliorate the conditions of human existence. The profession in which the members of this association are engaged could not exist at all if capital withdrew its support from enterprises depending upon the genius and ability and conscientious effort of the electrical engineer.

I urge upon all of you to carefully consider this subject, to avoid the influence of the idea that the professional engineer can get along without the services of capital. Capital on its part must treat the public, the laboring man and the professional man with fairness and liberality, with more fairness and liberality than it has in the past. On the other hand, the professional man who from the nature of his calling and its dignity carries a large influence in the community in which he operates must not forget the close co-relation between brains, labor and capital, and neither through professional indifference or professional jealousy allow himself to give capital an unfair hearing or an unjust decision.

We must avoid the fallacy that only the physical portion of a corporation's property is entitled to a value, a fallacy which has led many engineers, many business men and many corporations to disaster. The facts being that beyond the naked physical value there is required a very large and material sum to change that naked inert mass of physical construction into a live, progessive, earning entity. The omission of the cost of making a going concern in addition to its naked physical value has been the root and cause, in my judgment, of a large proportion of the disasters which have overtaken enterprises in the field in which we operate.

These remarks and more to the same effect apply to the question of intangible values and when called upon to deal with these matters I hope the fullest consideration will be given to them. These intangible values generally embrace interest during construction, accidents and insurance during construction, engineering charges, supervision charges, and they should include proportionately, the tremendously large sums expended by public service corporations in developing the business, in educating the public, and producing a sale of their commodity, whose reflex effect in subsequent reduction of the operating charges should be considered as proper cost in the value of the property. Further proper charges, of an absolutely legitimate nature, to the intangible value account include the legal expenses of organization and of putting the enterprise on its feet, the discounts on securities sold or brokerage paid for finding of the capital and particularly in the case of the older companies, the large sums spent in absolute good faith in what was really a period of experimenting to obtain the best apparatus, the best systems, and methods adapted to the requirements of the company happening to be in question. Due regard should always be given to the added cost of piecemeal construction which has been an unfailing incident of all of these corporations. In all fairness it should include the losses due to obsolescence and the discarding of workable machinery long before its life had been exhausted, this discarding being for the purpose of keeping pace with the times and in the last analysis for the better serving of the public.

There is a tendency, I hope a diminishing tendency, to be unfair to public service corporations and to be entirely oblivious of the hazards and risks they have incurred in the building of their business and to be forgetful of the profound importance and great

benefit they have been to the communties they serve.

A recent example and a very pertinent one of this tendency to be unfair has occurred in the appraisal of the value of one of the largest utilities in a large western city. The appraisal was for the purpose of determining the proper reproduction or replacement value of this utility. The formula was rather clearly understood as pertained to the physical property, deductions were to be made and were made for the accrued depreciation, allowances were made for what had evidently been unusually expensive piecemeal construction and matters of that description, the theory being that as regarded the physical value of this property, its appraised value would represent what it would cost to reproduce the property in its present condition.

In general this formula was carried out fairly until it was found that a material part of the distributing system of this company was now under paved streets, but that due to the enterprise or necessity of the company in the past a part of its underground system had been placed in the streets in question before they were paved; that is, the paving above this underground system on a material portion of the company's property had taken place after its distribution system was in the ground. The ruling of the body making this appraisal was that this company was not entitled as a part of its value to the cost it would have been put to of placing this distribution system under the paved streets and the difficulty of sustaining this ruling is plainly evident from the fact that wherever this company has put its distributing system underneath paved streets or where it is doing it today, the cost of that paving is applied to this company and is allowed as a part of the value of their plant. It would be hard to conceive of a more direct effort to discourage enterprise than this particular ruling. If the company had waited to put all of its distributing system under the paved streets until the paving was down and had then ripped it up and buried its distributing system they would have been allowed the cost of taking up and replacing the paving. Because they did it in advance they were not allowed that cost. This particular city is far better off from the course which that company pursued because its pavement over that particular portion of the distributing system was not injured by being taken up to put the distributing system underneath it.

We all believe we are approaching a far better understanding between all parties concerned [illegible] questions than has existed in the past. The [illegible] all of us must be by conscientious effort, by [illegible] and sincerity to bring around this better [illegible]. However, with the tendency of the governing [illegible] to make decisions such as I have just referred [illegible] extremely important it becomes for the engineer [illegible]trusted with the making of an appraisal to be sure that he has not underestimated, to be sure that so far as his intelligence and authority go he gives to the property under consideration the benefit of all the value he believes it is entitled to, both physical and intangible.

A highly instructive and deeply intellectual article on one extremely important detail entering into this subject of appraisals is before the association in an article on that subject by Mr. Henry Floy, who approaches the matter of his very able paper from an ample preparation and a long experience.

In closing I desire to urge upon all of you a sense of the responsibilities now being thrust upon us; to urge upon you a sense of the dignity of our calling, and to express the hope that with the usual opportunities possessed by the members of this organization for forming a basis for a proper measure of the questions of values; that we approach these subjects with high intelligence, with a profound sense of the responsibilities resting upon us and with appreciation of the fact that in the combination of capital, the public and professional engineers, no hardship can be worked to any one of the three without inevitably producing its full quota of disaster to the others.

FLOW OF STREAMS AND THE FACTORS THAT MODIFY IT[1].

BY D. W. MEAD.

The quantity and regularity of stream flow and its variations are matters of much importance in hydraulic engineering, and equally so to many of the business interests and enterprises. Public attention has recently been called to various questions relative to water power and internal navigation, while questions of water supply, drainage, and flood protection are no less important to the public welfare. One of the most important elements in the solution of all of these problems, and of many others almost equally important, is the condition of stream flow or runoff. The application of storage for the prevention of floods and for the promotion of uniformity of flow for navigation power and water supply purposes, has been much discussed, and many opinions have been expressed as to its possibility, desirability, and value. The value of forests for increasing or equalizing stream flow has been widely discussed, and opinions greatly at variance have been expressed both favorable and unfavorable to such influences. It has also been suggested that water powers of the state be taxed to provide for the reforesting of the head waters of the streams on the theory of direct benefit, and bills providing for such a tax have been offered in the legislature. The arguments that have been presented to sustain the various opinions that have been expressed on many of these questions have seldom been satisfactory or conclusive, except to their authors. Much incomplete and half-considered data have been offered to sustain the contention of the advocates of both sides of many of the debatable questions, and in few cases have the arguments been based on such complete data that the conclusions have not been open to serious question. In many cases the advocates of various theories have apparently sought only for such data as would support their personal views, and have minimized or ignored the data that might suggest a contrary view of the question at issue.

It has appeared to the writer that while most of the questions at issue are exceedingly complicated, and while the data available for the solution of these problems are more or less incomplete and unsatis-

[1] Extracts from Bulletin No. 4251, University of Wisconsin.

factory, yet a careful examination of such data, in considerable detail, on scientific lines might lead to definite and well substantiated conclusions, at least in regard to a limited area. With this idea in view, the writer has made a somewhat detailed study of this subject with special regard to the conditions prevailing in the State of Wisconsin; and while the data examined and considered are too numerous to present in print, he has endeavored to select certain typical locations from which data were available and has endeavored to present the study of the conditions that prevail therein in sufficient detail to warrant the opinions expressed in his conclusions. In most, if not in every case cited the data on which the opinions rest are presented so completely that the rationale of his conclusions can readily be understood. Where the data have not been presented, the source from which they were obtained and from which they can readily be verified has been stated.

The writer would by no means have it understood that he has not had definite opinions on many of these subjects, but he has approached this study with an open mind and with a strong desire to ascertain the truth, in whatever form it might appear. His personal interest in hydrological science and in practical hydraulic developments makes it most important to him that the truth be determined if possible.

If forests will improve the regularity of streams and prevent floods, if they will conserve and increase the low water flow, if they will prevent denudation and increase the depth of streams, it is most important that these facts be known. If, on the other hand, such effects are purely imaginative or unimportant, it is equally important that that fact be known so that unjust laws and useless expense shall be avoided.

If it is practically possible to construct reservoir systems on the head waters of some or all of the streams of the state, and, by storage, to economically regulate their flow and radically increase the available low water power of the streams and their availability for navigation purposes, such facts and their limitations are of great importance to the citizens of the state. The effects of the draining of swamps and of wet land, the cultivation of agricultural lands, and of various other artificial changes in normal conditions should also be known and appreciated in order that their effects may be obviated if harmful, or emphasized if beneficial, to as great a degree as possible.

The Problem of Runoff.

The portion of the rainfall that is discharged in the surface flow from a drainage area is termed the "runoff" from that area and may occur, in the case of water flowing from areas of considerable magnitude, as a definite stream or, when small areas are considered, merely as the surface drainage not confined to a definite channel.

A brief examination of the subject shows that the factors that modify and control runoff are very numerous and differ in intensity and in effect with every drainage area considered. While the relative runoff from each area will agree more or less closely with that of other areas on which the conditions are similar, there are always variations which occur in these conditions that make them so dissimilar as to create greater or less difference. The causes of such differences are not always manifest as it is often impossible to obtain a sufficiently exact knowledge of the detailed conditions prevailing over an entire drainage area so that more than approximate conclusions can be drawn. Nevertheless, a discussion of this subject, based on scientific considerations, may so clearly set forth the principles involved in any specific case that the dominating influences can be clearly seen and the extent of the influence of any particular factor, if important, may be quite clearly realized and appreciated.

Resume of the Factors That Modify or Control Runoff.

1. Precipitation—
   - (a) Whether it occurs as rain or as snow.
   - (b) The amount of each, and the total annual precipitation.
   - (c) Its distribution throughout the year.
   - (d) Its intensity or manner of occurrence.
   - (e) The character of storms, including their direction, extent and duration.
2. Temperature—
   - (a) The variations of temperature on the area.
   - (b) The relation of extreme temperatures to the occurrence of precipitation.
   - (c) The accumulation of snow and ice, caused by low temperatures.
   - (d) The occurrence of low temperatures causing the freezing of the ground surface at times of heavy spring rains, resulting in excessive runoff.
3. Topography of the Drainage Area—
   - (a) As to whether the surface is level or inclined, and the degree of inclination.
   - (b) As to character of area, whether smooth or rugged.
4. Geology of Drainage Area—
   - (a) Whether pervious or impervious.
   - (b) If pervious, whether such pervious deposits are (a) shallow or deep; (b) level or inclined; whether the outlet or point of discharge of the pervious deposits are (c) in the lower valley of the same river, or (d) in valleys of other rivers, or in the sea.
   - (c) As to the condition of the channel of the stream, whether (a) pervious or impervious; (b) whether or not the bed contains more or less extensive deposits of sand and gravel, permitting of the development of a more or less extensive underflow.
5. The Condition of the Surface—
   - (a) Whether bare or covered with vegetation.
   - (b) Whether in natural condition or cultivated.
   - (c) Nature of vegetation, whether grassland, cultivated crops, or forests.
6. The Character of the Natural Storage on the Drainage Area—
   - (a) Nature and extent of surface storage, consisting of lakes, ponds, marshes, swamps.

(b) Nature and extent of ground storage, consisting of gravel, sand, and other similar pervious deposits.

7. The Nature of the Drainage Area Considered—
   (a) As to size, whether large or small.
   (b) As to shape, whether long and narrow, or short and broad.
   (c) The location of the area relative to prevailing winds.
   (d) The direction relative to the path of storms.

8. Character of the Stream and Its Tributaries—
   (a) As to slope or gradient, whether flat or inclined.
   (b) As to falls and rapids on the stream.
   (c) As to the section of the stream, whether deep or shallow.
   (d) As to the arrangement of tributaries, whether joining the main stream at various points along its course or concentrated in a fan-like arrangement at a more or less common point of discharge.

9. The Artificial Control of the Stream
   (a) As to dams and storage reservoirs on the drainage area.
   (b) As to the restrictions of the river [illegible] dikes and levees.
   (c) As to the obstruction of the stream by piers, abutments, and other encroachments [illegible] adjacent to the waterway.

10. The Artificial Use of the Stream
   (a) For irrigation.
   (b) For water supply.
   (c) For the supply of navigation canals.
   (d) For artificial storage and regulation of the [illegible]

11. Character and Extent of the Winds on the Drainage Area—
   (a) As to their intensity and direction.
   (b) As to the modification of the same [illegible] and forests.

12. Ice Formation—
   (a) As modifying the winter flows of the stream.
   (b) As to the formation of ice gorges and accompanying floods.

Conclusions.

From a detailed study of the general relations to runoff or stream flow conditions in Wisconsin, the following conclusions can be clearly drawn:

1st. That in general the quantities and [illegible] of stream flow are due to a large number of concomitant factors, some fixed and some variable, each [illegible] an influence in proportion to its own character, intensity and the relative character and intensity of every other factor. The combinations of these [illegible] are so numerous, and differ so widely even on a single drainage area, that no problem of flow can be determined even approximately from a consideration of the factors themselves except by means of a comparison with the actual relative effects under circumstances more or less similar to those under investigation.

3rd. That the mean annual stream flow on any stream, and the variation in the stream flow throughout the year, depend mainly on the quantity and distribution of the precipitation, modified by temperature conditions.

4th. That extreme floods are due to the simultaneous occurrence of temperature and precipitation conditions, favorable to excessive runoff, and that no practicable works of man, such as drainage works, reservoirs, or reforestation, can materially affect the flood peaks on the larger Wisconsin rivers.

7th. That the uses for which reservoir systems may be constructed are essentially antagonistic and that the specific use to which they should be applied must depend on the local conditions which may modify the relative values of the services which they can fulfill.

9th. That if forests have any effect on stream flow that can be assigned a practical value, such effects must be manifest by an actual change in the conditions of flow when deforestation occurs, and that if deforestation is not accompanied by an actual change in the stream conditions, the effects are entirely theoretical and practically valueless.

12th. That while theoretically forests will decrease the amount of precipitation reaching the earth's surface, thus decreasing the water supply of streams, and, under certain circumstances may afford a limited storage which may aid in the regulation of stream flow, yet the examination of the actual flow of the streams of Wisconsin shows no indication of such effects.

13th. That if any effects on stream flow have resulted from deforestation they have been entirely counteracted and obscured by the drainage of marshes, the clearing of farm lands, the second growth of timber and brush, or other similar occurrences.

14th. That so far as all evidence examined is concerned, there is nothing to show that the planting of forests in Wisconsin would in any way add to or take away from the quantity or regularity of stream flow, or decrease the flood heights.

15th. That therefore the reforestation of the headwaters of Wisconsin streams cannot be expected to add to the quantity or regularity of the power which may be developed on any [illegible] change or improve the flow of the stream for any other useful purpose.

Finally:

16th. That the changes and fluctuations in the flow ratio in Wisconsin rivers are [illegible] undetermined factors which modify the precipitation [illegible] similar [illegible] distribution of the annual rainfall. Such phenomena occur in cycles and are not found to be continuously favorable or [illegible] to the quantity or regularity of stream flow.

17th. [illegible] Wisconsin streams as shown by [illegible] annual, [illegible], and maximum and minimum flows, [illegible] either increased or decreased during the last thirty-five or forty years except as [illegible] been caused by the annual and seasonal variation in the quantity and distribution of the rainfall, together with the modifying effects of the accompanying temperature.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
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CONTENTS

Surge Pipes

The control and, if possible, the prevention of surges in high head pipes is of vital importance in the operation of water power plants. Surges bring about an erratic power supply by disturbing the turbine governors and they may even burst the pipe by water hammer, so familiar when domestic water supply is quickly shut off. The sudden stoppage of a column of hundreds of tons of moving water greatly strains the strength and elasticity of the pipe and sets up this vibratory motion known as a surge.

For many years this was overcome by an ample factor of safety for the pipe and by providing outlets which could not be closed within a certain predetermined time, due operating care also being exercised to avoid its causes. As the enclosing conduit is lengthened the problem becomes more complex, usually being solved by making an outlet as close to the point of sudden stoppage as the conditions of the installation will permit. This outlet takes the form of the standpipe or surge-pipe so frequently seen in modern plants.

A safety valve is supplied with the surge pipe to afford relief from the possibility of bursting the pipe. The sudden diminution of the outlet flow will set up a surge disturbance unless some sort of by-pass is provided to automatically discharge an amount of water proportional to that which is shut off in a given interval of time. It is impractical to design such a device for every and all conditions.

In a paper presented at the San Francisco meeting of the American Society of Mechanical Engineers this week, Professor W. F. Durand of Stanford University has worked out a method which permits direct calculation of the elements of a surge chamber to meet any predetermined program of time-acceleration of water in the conduit. Contrary to the precedent of a cylindrical pipe his mathematical deductions suggest a funnel shape. This theory has been successfully applied to practice in the case of one of the power plants of the Los Angeles aqueduct, whose closed conduit consists of a tunnel and pipe over seven miles long, having an area of one hundred square feet and a maximum flow of about one thousand cubic feet per second. Figures are unnecessary to convey an idea of the enormous mass of water whose movement must be accelerated or retarded in governing this plant and the method of calculation which Professor Durand has devised is of the greatest interest to engineers.

His work is a long step forward in the rationalization of hydraulic technics, which has long suffered from too little theory. The laws which govern the theory water flow are less clearly understood than those in almost any other branch of engineering. The formulae are empirical and based on data appertaining only to special cases and the methods are rule-of-thumb. Having passed through the period of deductive development, "its facts being reproducible in the mind without constant recourse to observation" it is now ready for its formal development, whereby facts are systematized so as to be reached and pictured with the least intellectual effort.

PERSONALS.

Frank H. Ray is at San Francisco.

Thomas Mirk of Hunt, Mirk & Co., has returned from a trip to San Diego.

C. E. Groesbeck, vice-president of the H. M. Byllesby Company, has returned to Portland, Ore.

Wynn Meredith is consulting engineer for the Sooke Lake water supply project of the city of Vancouver, B. C.

B. C. Carroll, general agent of the Pacific Telephone & Telegraph Company, spent the past week at Los Angeles.

A. G. Wishon, general manager of the San Joaquin Light & Power Corporation, was at San Francisco during the past week.

Carl L. Wernicke, in charge of the Westinghouse Electric & Manufacturing Company's Portland office, is at San Francisco.

Thornwell Mullally, assistant to President Patrick Calhoun of the United Railroads, made a trip to Cleveland, Ohio, last week.

B. C. Condit, who has been engaged in electrical engineering investigations in Oregon during the past few months, is at San Francisco.

C. M. Bliven, Seattle manager for the General Electric Company, has returned from the meeting of the supply men at San Francisco.

J. H. Cain, who is at the head of the Novato Light & Power Company of Novato, was a San Francisco visitor during the past week.

Elam Miller, commercial engineer with the Pacific Telephone & Telegraph Company, is making a month's trip throughout the East.

O. H. Ensign, electrical engineer with the Reclamation Service, with offices at Los Angeles, is at Boise, Idaho, examining the Arrow Rock project.

E. D. N. Lehe, who had electric power interests in the neighborhood of Dixon and Martinez, has left California for a European tour with his family.

A. M. Hunt returned to his San Francisco office last Monday, after spending several weeks at New York and Eastern manufacturing centers.

J. A. Cranston, the Pacific Northwest district agent for the General Electric Company, with headquarters at Portland, was at San Francisco during the past week.

A. C. Balch, who is interested in the Pacific Light & Power Company and other Huntington corporations in Southern California, was a recent San Francisco visitor.

H. H. Noble, president of the Northern California Power Company, has returned to his San Francisco office after an inspection tour of the entire hydroelectric system, including the new 20,000-h.p. Coleman plant, which is nearing completion.

E. W. Florence, who was formerly connected with the Pacific Gas & Electric Company at Fresno, has gone to Redwood City as manager of the Redwood district, succeeding L. H. Newbert, who has been placed at the head of the company's new business and appliance department with headquarters at San Francisco.

S. S. Philbrick, manager of the Lewiston & Clarkston Improvement Company, which has an extensive electric power transmission system in operation, is at San Francisco from Clarkston, Wash. The company has hydroelectric plants at Pomeroy and Asotin in Washington and a steam plant at Clarkston. Lewiston, Idaho, and a number of other cities are supplied with electric power.

Sidney Sprout has returned to San Francisco from Siskiyou county, where he is superintending the engineering work on the new 35,000-kilowatt hydroelectric installation of the Siskiyou Light & Power Company. Three generating units will be installed. The power site is on the Klamath River, near Thrall. In addition to tieing in with the company's existing power transmission lines from the Fall Creek power station the new lines will be extended to Klamath Falls where the company recently purchased a local electric plant.

Samuel J. Taylor, who resigned as secretary and treasurer of the Oakland Traction Company, the Key Route, and the California & East Shore Suburban railways, has accepted the position of financial secretary of the Peoples Water Company. Frank W. Frost, for nineteen years connected with the Oakland Traction and Key Route systems, succeeds Taylor. Mr. Frost, at the time of the Smith-Tevis merger, went to the San Francisco offices of the United Properties Company. Angus Clark, who has been with the traction company for the past four years, will succeed Mr. Frost as assistant secretary.

W. W. Briggs has been appointed assistant sales manager of the Westinghouse Electric & Mfg. Company, with headquarters at San Francisco, and jurisdiction over the Pacific Coast. This announcement comes as a pleasant surprise to Mr. Briggs' many friends on the coast, where he has been active in the electrical business ever since 1886, when he began as shop boy in the arc lamp repair department of the California Electric Light Company. Later he became connected with the Electric Improvement Company, as competitors of Central Lighting Stations in San Francisco, leaving the company to go to Idaho as electrician for a mining company in 1893. In 1896 he returned to San Francisco and joined the sales force of the Fort Wayne Electric Company, leaving there to join the sales department of the Westinghouse Electric & Mfg. Company, on January 1, 1899. He was made district manager of the Westinghouse Electric & Mfg. Company in May, 1905, which position he has held to date. His new duties will be outlined by the sales manager at Pittsburg and his time will be occupied in the development of the company's business in California, having general oversight of the San Francisco and Los Angeles offices.

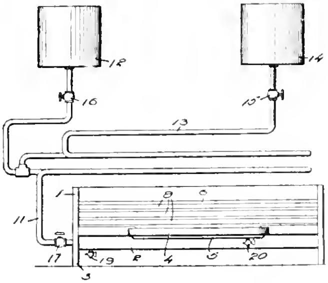
TRADE NOTES.

The Empire Construction Company has opened offices in the Exchange Building, Seattle, Wash., to engage in electrical contracting and engineering work. J. F. Ne Page and V. S. McKenney are interested.

The United Railroads of San Francisco have recently converted their Mason and Washington Power Station from steam to electric drive, so that all their cable lines are now motor driven. The Castro and Pacific Avenue Stations are operated with D. C. motors, while at Mason and Washington Station the new installation is all A. C. apparatus, the motors being 600 h.p., 400 r.p.m., 440 volts, the controllers reversible and the characteristics of the motors along with grid rheostats are such as to permit running for one-half hour at one-half speed and full torque in either direction. The speed of all cables has been increased about 3 per cent and owing to the practically constant speed of the motor the cables travel at a much more uniform speed now than with the old equipment, it being impossible to control the steam engines with less than 5 per cent. The equipment has been installed by W. T. Bivins, Chief Engineer Electrical Equipment.

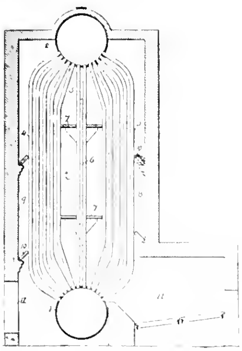
PATENTS

995,511. Crude-Oil Burner. John C. F. Woodworth, Phoenix, Ariz., assignor to I. J. Lipsohn, Phoenix, Ariz. An oil burner, comprising a receptacle, a burner plate arranged at an angle in the receptacle to provide a mixing chamber between the plate and the bottom of the receptacle, said plate



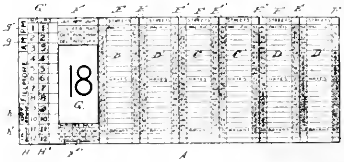
having perforated ribs formed thereon, a perforated pipe mounted in the chamber and having an end projecting from the casing, fuel supply coils extending above the burner plate and connected with the perforated pipe, and means for controlling the flow from the coils to the pipe.

995,523. Water-Tube Boiler. Wilfred D. Chester and Henry B. Rust, Pittsburg, Pa., assignors to The Babcock & Wilcox Company, Bayonne, N. J. In a water-tube boiler having horizontal water and steam and water drums, a group of straight tubes adjacent to a vertical plane passing through the center line of the two drums, groups of bent tubes on either side of said group of straight tubes placed at a distance



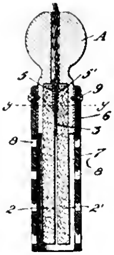
from the said group of straight tubes a sufficient distance to allow a man to enter the said space, a wall between the straight tubes and supported by them, said wall resting on the water drum and extending from side wall to side wall, and horizontal baffles supported by said vertical wall and the straight tubes and extending from the group of straight tubes toward the group of bent tubes, and inclined baffles extending from the front and rear walls to the bent tubes.

995,917. Transfer-Ticket. Frank W. Sheum, San Francisco, Cal. A street railway transfer ticket comprising a body having on the face thereof a plurality of independent columns each containing in sequence the names of the transfer points along the route of the car, hour indications on the transfer for designating when punched the hour of the car's departure, numerical indications at the head of each of the columns on the ticket, one of which is adapted to be punched to indicate the time in minutes of the departure of the car, the body of said transfer being also provided with numerical indications adjacent the names of the several transfer points in each column, the numerical indication opposite any of such



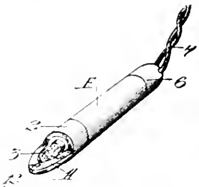
transfer points in the column which has been punched to indicate in minutes the time of the departure of the car indicating in conjunction with the hour indication on the transfer which has been punched the time limit for the use of the transfer at such transfer point, said body being also provided with a table of numerical indications thereon adapted when punched to vary the reading of the indications opposite the transfer points to the extent of the number punched.

995,591. Electric Heater. Thomas E. Fogalsang, San Francisco, Cal., assignor to Joseph A. Moross, San Francisco, Cal. An immersion electric heater comprising a handle having a tubular end forming a chamber, a pair of exposed, carbon



electrodes each having one end fixed to the chamber of the handle, means for holding the electrodes apart to provide an intermediate water heating space, and a perforated inclosure for the electrodes, said inclosure being fixed to the tubular end of the handle.

995,778. Electric-Lighted Finder. Frank L. Fitch, Santa Cruz, Cal. A finder comprising a barrel, a removable cap at one end thereof, an electric light bulb fitted to the other end

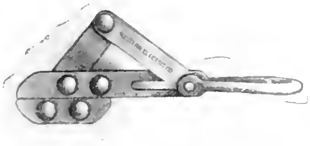


of the barrel, and a guard fitted to said last-named end and extending lengthwise therefrom, and having an axially disposed light opening in the end.

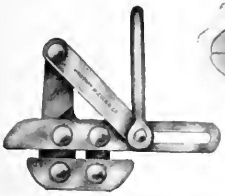
INDUSTRIAL

A NEW LOCKING FEATURE FOR THE IMPROVED BUFFALO GRIP.

The Western Electric Company has recently placed on the market a new "Improved Buffalo Grip" with a special locking feature. In Fig. 1 the new grip is shown with the jaw held open by the locking device. A turn of the handle



Buffalo Grip with Jaw Closed



Buffalo Grip with Jaw Held Open by New Locking Device

locks the jaw in any position and enables the lineman to easily and quickly insert the wire in the grip. When the handle is pushed down as shown in Fig. 2 the wire is held in a tight grip.

The "Improved Buffalo Grip" is made in various sizes for both bare and insulated wire, and can be supplied both with and without pulleys.

NEW INDICATING BOILER FLOW METER.

The betterment of station economy demands not only the employment of well-trained firemen and properly designed fire tools, but also the use of such instruments as recording pressure gauges, feed water thermometers and steam flow meters, to furnish the information by means of which high efficiencies and economical results can alone be obtained.

The new FS-2 boiler meter developed by the General Electric Company is designed to indicate the total amount of steam generated at any instant by a boiler or a battery of boilers in pounds of steam per hour, or in boiler horsepower. Therefore, it can be advantageously used for obtaining data for equalizing the load on individual boilers or a battery of boilers; for determining the efficiency in the method of stoking, or the correct feed water circulation; for determining the deterioration in efficiency due to the formation of scale; for discovering internal leaks as shown by the difference in water input and steam output; and for indicating the amount of steam distributed to different departments of a manufacturing plant, or the amount used in various manufacturing processes. In other words, it constitutes a valuable aid to engineers and firemen in maintaining an intelligent oversight of the fireroom.

The meter apparatus complete consists of a nozzle plug, the meter proper and the necessary pipes for connecting the nozzle plug to the meter.

The nozzle plug is similar to those used with the general line of steam, air, and water flow meters manufactured by the General Electric Company. It consists of a screw plug, provided with a stem having two sets of orifices—a leading set arranged longitudinally and a trailing set comprising three holes, located at the middle of the stem and at right angles to the leading set. The interior of the stem is divided longitudinally into two separate compartments, the leading set of orifices opening into one, and the trailing set opening into the other.

For operation, the nozzle plug is screwed into a small hole drilled and tapped in the steam pipe, with the stem extending across the pipe and the leading set of orifices facing the direction of steam flow. When thus arranged, the velocity of the steam causes a certain difference of pressure to exist in the two sets of orifices, and this difference of pressure is communicated through suitable pipes connecting the compartments in the nozzle plug stem with the U tube of the meter.

The body of the meter consists of an iron casting cored out to form one leg and the well of the U tube, the other leg being formed by one of the nozzle-plug connecting pipes entering the well at the opposite end. The well is filled with mercury, and the rest of the apparatus including the connecting pipes and the compartments in the nozzle plug is filled with water.

The movable mechanism of the meter comprises a small float resting on top of the mercury in one of the legs of the U tube and attached to a waterproof silken cord passing over a pulley and held taut by means of a counter balance weight acting on the pulley in the opposite direction, and a pair of horseshoe magnets—one inside the meter, attached to the pulley shaft, the other outside the meter, fixed to the pivoted end of the indicating needle. The axes of rotation of the two magnets are in line, and their mutual attraction exerted through a copper plug screwed into the side of the meter body casting, compels them to move in unison.

When the difference of pressure caused in the nozzle plug by the velocity of the steam flowing in the steam pipe is communicated to the two legs of the U tube, the mercury in the well rises or falls in the leg containing the float to a height proportional to the difference of pressure. The resulting motion of the float rotates the pulley, and the motion of the latter is transmitted through the pair of magnets to the indicating needle. The employment of the pair of magnets obviates the use of the troublesome packed joint which would be necessary for transmitting the motion of the pulley inside the meter to the indicating needle on the outside, by means of any form of mechanical connection.

The meter is easily installed, without interfering in any way with existing steam pipe arrangements. The work of installing merely requires the drilling and tapping of a small hole in the steam pipe for the insertion of the nozzle plug. The design of the latter permits of its insertion in pipes running either vertically or horizontally. Care should be taken, however, to select a straight run of pipe of at least 12 pipe diameters in length. The meter itself can be located in any desired place so long as it is kept below the nozzle plug. Its distance from the nozzle plug is immaterial, and it should be connected to the same with $\frac{1}{4}$-inch iron pipe of the required length. The best location is on the front of the boiler near the steam gauge, in plain view of the fireman and the engineer.

The dial scale is 8 inches in diameter marked with heavy flow lines and large figures on a white surface, for easy reading. A target of conspicuous size is provided for designating a certain flow on the scale. This target can be readily set from the outside.

The meter can be calibrated to read in pounds per hour or in boiler horsepower (30 pounds of steam per hour being taken as equivalent to one boiler horsepower), for pressures ranging from 0 to 250 pounds, gauge; for quality ranging from 4 per cent moisture to 260 degrees F. superheat; and for pipe diameters of 2, 3, 4, 6, 8, 10, 12 and 14 inches. Meters calibrated for pipes larger than 14 inches in diameter can be furnished on special order. It will be noted in this connection that for any given case a meter of this type is calibrated for a certain pressure, quality and pipe diameter, and cannot be used for any other condition.

NEW CATALOGUES.

Bulletin No. 1152 from the Pittsburg Transformer Company lists two sizes of bell ringers, both transformers having three low voltages.

The Crocker-Wheeler Co. of Ampere, N. J., have issued a booklet on the efficiency of the Remek transformer, whose construction is illustrated in detail.

Bulletin No. 4850, recently issued by the General Electric Company, describes the new drawn wire tungsten filaments with which Mazda lamps are now equipped.

Hoskins electric furnaces and pyrometers are illustrated and described in a catalogue being distributed by the Machinery & Supply Co., Seventh and Harrison streets, San Francisco.

The Duncan Electric Manufacturing Co. of Lafayette, Ind., have just issued a new bulletin on the Duncan Model E Watthour Meter. The text describes a number of the good points of this meter in a most interesting manner.

The Machinery & Supply Co., Seventh and Harrison streets, San Francisco, are distributing catalogues descriptive of the Dietz Aerolectric Rock Drill, manufactured by the Economic Machinery Company of Denver, Colo.

Bulletin No. 1076 from Allis-Chalmers Co., on Power Transformers describes the theory underlying the construction of power transformers and shows illustrations of the various details of manufacture. Tables of efficiency and heating are also included.

Bulletin No. 4833, recently issued by the General Electric Company, describes a number of installations of electrically operated gold dredges, and contains information which should be of great interest to all connected in any way with this industry.

Bulletin No. 1081 from the Allis-Chalmers Company covers their polyphase induction motors. This bulletin contains a complete description of both Types "AN" and "ANY," together with photographs showing the details and applications of these motors. A list of ratings is also included.

In Bulletin No. 4835 the General Electric Company illustrates and describes various types of motor driven pumps designed for different purposes. Among the pumps illustrated are those for mine uses, pumps for operation in sewage disposal plants and dry docks, for irrigating purposes, and for use in connection with the water supply of houses.

Bulletin Nos. 1826 and 4827, just issued by the General Electric Company, describe that Company's water and air flow meters, respectively. The General Electric water flow meter provides a means of obtaining accurate information which will show the amount of water pumped, consumed or distributed. The General Electric air flow meter provides a means for obtaining accurate information showing the exact amount of air compressed or distributed. Each bulletin contains a more or less detailed description of the meter to which it refers, and should be of interest to all users of air and water as working agents.

Two bulletins have recently been issued by the Engineering Department of the National Electric Lamp Association, the one entitled "Economical Operation of Incandescent Lamps" and the other "Mazda Incandescent Street Lighting." The first of these gives a detailed technical discussion of the principles involved and the methods to be used in determining conditions of most economical operation for incandescent lamps from the standpoint of both consumer and central station. The text is elucidated by numerous curves and tables. The bulletin on street lighting is a revision of a former bulletin on this subject and gives distribution curves for some of the latest types of reflectors.

TRADE NOTES.

D. C. and Wm. B. Jackson, engineers at Chicago and Boston have moved their Chicago office from the Commercial National Bank Building to the 20th floor of the new Harris Trust Building, 111 West Monroe street.

J. P. Hermans has returned to San Francisco from a successful trip through the San Joaquin Valley in the interests of Colonial and Economy lamps handled by the Colonial Electrical Agency, San Francisco.

The Western Electric Company has recently received an order from the Oregon-Washington Railroad and Navigation Company for telephone train dispatching equipment for a circuit from Portland, Oregon, to The Dalles, Oregon, a distance of ninety miles. This circuit will be equipped with seventeen stations.

The Farnsworth Electric Works reports that their shop is exceptionally busy on repairs and redesigning of large apparatus. They report the sale of a 150 h.p. 2200-volt, three-phase induction motor to the Pacific Fruit Cooling and Vaporizing Company for use in their plant at Lodi, Cal., and a sale to the Grant Gravel Company of three 50 kw., 11000-volt primary 2200-volt secondary station type transformers. Another recent sale is that of a 100 kw., 250-volt railway type d.c. generator to the E. B. & A. L. Stone Company for use at their rock quarry railway at Thomasson, Cal.

Appreciating the growing importance of steel construction in tower transmission lines, the American Bridge Company of New York have decided to specialize on this class of work. While this company have in the past built structures for this purpose, they realize that permanent lines involving steel towers are becoming necessary, and that the larger public service companies must eventually rebuild existing lines with more stable equipment. Announcement has been made concerning the handling of work in this field. The firm of Pierson, Roeding & Co., of San Francisco, have been appointed the special representatives of the American Bridge Company for the Pacific Coast for the sale of poles and towers for electrical transmission. The activity of this well known firm in transmission work will be sufficient to guarantee that the American Bridge Company will furnish a fair share of this class of work.

CONTRACTORS' NOTES.

There will be quite a large electric wiring job on the new Native Sons' Hall which is under construction at San Francisco. Rhegetti & Hedman are the architects.

A seven-story hotel is being erected on the north side of Bush street, between Powell and Mason, San Francisco. The electric work will amount to about $5000, according to estimates. J. C. Newsom is the architect.

Specifications are out for the electric wiring for a large modern hotel which is being erected on the north side of Market street, between California and Sacramento, for the Pringle estate. Wm. Curlett & Son of San Francisco are the architects.

The Downtown Realty Company is erecting a theater and hotel building to cost about $300,000 on the southwest corner of Eddy and Mason street, San Francisco. If the electric work is as elaborate as is expected it will run from $20,000 to $25,000.

Plans are being figured for the electric work on the new Pantages Theater on Market street, opposite Mason, San Francisco. The electric work is estimated at approximately $1500, including a stage switchboard, etc. Miller & Colmesnil are the architects.

NEWS NOTES

FINANCIAL.

JACKSON, CAL.—That the Western States Gas & Electric Company intends to improve and develop its holdings in Amador county is evidenced by the filing of a mortgage covering its entire holdings. The mortgage is given to the Girard Trust Company of Philadelphia, and is for $10,000,000 at 5 per cent, the life of the mortgage being forty years, from June 1 of the present year. The mortgage is secured by the holdings of the company, including the Richmond Light & Power Company of Contra Costa County, the Stockton Gas & Electric Corporation of Stockton, the Humboldt, San Joaquin, Calaveras, Sacramento River Electric Company and land and water rights in Humboldt, San Joaquin, Calaveras, Sacramento and El Dorado counties. The purpose of the mortgage is to raise a fund to buy, develop and equip additional properties.

PUEBLO, COLO.—H. M. Byllesby & Company confirms the report of purchase of the Pueblo & Suburban Traction & Lighting Company and allied interests in Colorado, the property being taken over June 11th. The Pueblo & Suburban Traction & Lighting Company operates the street railway system of Pueblo and supplies electricity to Pueblo and the Cripple Creek gold mining district, including the cities of Cripple Creek, Victor and Goldfield. The towns of La Junta and Rocky Ford are served with electricity by subsidiary corporations. A steam electric power station of [illegible] Pueblo and a hydraulic power plant of 1600 kw. at [illegible] are operated. Arrangements are being made to [illegible] the capacity of the steam station at Pueblo and to extend transmission lines to serve additional cities and towns. Additional hydroelectric developments also are contemplated. W. F. Raber is at present in charge of management for Byllesby & Co.

INCORPORATIONS.

HERMISTON, ORE.—Hermiston Light & Power Company has been incorporated with a capital stock of $10,000.

PORTLAND, ORE. Articles of incorporation [illegible] filed by the Clatskanie Electric Light & Power Company, which is capitalized at $50,000.

SALEM, ORE.—Articles of incorporation have been [illegible] by the Bully Irrigation & Power Company. Their principal office will be at Vale, Ore.; capital stock $25,000.

ILLUMINATION.

ROSEBURG, ORE. Oakland, Oregon, has voted in favor of the issuing of $10,000 for a municipal lighting system.

HALSEY, ORE.—The Oregon Power Company has [illegible] granted a franchise for the construction of a lighting [illegible] here.

KLAMATH FALLS, ORE. The county has [illegible] grant a gas franchise and it is suggested to erect a [illegible] plant.

LOS ANGELES, CAL. The town of El Modena, in the foothills, is planning to have electric light and power, also to have gas piped into the town.

EL PASO, TEX.—B. P. Dubinski of El Paso has been given the contract for inside wiring for electric lighting at Fort Bliss. The Westinghouse Electric Company secured the contract for meters and transformers, and F. W. Newberry Electric Company of St. Louis has the contract for outside wiring. The entire cost will be $23,000.

LOS ANGELES, CAL.—The Southern California Edison Company has awarded to J. C. Farrar & Co. the contract to install certain electrical apparatus, including switches, switchboards, etc., at the Long Beach steam plant, Long Beach, Cal.

TRANSMISSION.

RIVERSIDE, CAL. The Board of Supervisors has granted to the Pacific Light & Power Corporation a franchise for fifty years to operate and maintain an electric pole and wire system on all public roads of the county.

LEAVENWORTH, WASH. The Tumwater Light & Power Company of this place has secured a franchise to construct and operate a light and telephone system from this place to Peshastin, then to the Chumstick river.

HOOD RIVER, ORE.—The Pacific Light & Power Company, which owns the Hood River water and light plant, proposes to increase its horsepower here and furnish power and light for farms between Hood River and The Dalles.

SEATTLE, WASH. The Washington-Oregon Railroad Company will start at once on the construction of a large power plant on the Skookumchuck River to furnish electricity to the Hercules & Sandstone Company of Tenino, Wash.

LAKEPORT, CAL. The Board of Supervisors has passed an ordinance granting to the Mt. Konocti Light & Power Company a franchise to put up an electric line to transmit light, heat and power along the public highways in the county of Lake.

EUREKA, CAL. Since the Western States Gas & Electric Company has taken over the holdings of the Fortuna and Ferndale lighting companies, improvements are to be made throughout the valley. The substation at Loleta will be moved further up the river.

WALLA WALLA, WASH. A franchise for 50 years has been granted the Pacific Power & Light Company, for a transmission line from Walla Walla City over the county roads to the Columbia county line, through Dixie and Waitsburg to Prescott. Construction is to begin at once.

BOISE, IDAHO. The electrical power transmission line of the Beaver River Power Company will be extended from the Malad River plant northward into Boise and through the Payette country about October next, is the statement made by L. B. Fuller, manager of the company, with headquarters at Bliss.

RENO, NEV. That there will soon be another power and light company doing business in this city and in other portions of Nevada in competition with the Hammon interests is now almost assured. The Nevada Power & Transportation Company will within a few weeks begin the construction of an 18-foot dam in the Truckee River near Vista, which will be used to back water up for the new power plant to be built there, and at the present time the company is building a power plant near Bishop, which will develop 35,000 h.p. when completed. This new company is backed by California capitalists, and it has named W. E. [illegible]ffrey, former city electrician of Reno, as its chief electrician. At the present time the Hammon interests controlling the Truckee River General Electric Company, has the monopoly of business of Western Nevada in power and lighting, and it is the intention of this new company to bid for a portion and to build a series of power plants in furtherance of the effort to obtain and retain it.

TRANSPORTATION.

VANCOUVER, WASH.—The Washington-Oregon corporation announced that they will extend the Main street car line.

BERKELEY, CAL.—E. C. Prather, engineer, Oakland, Cal., has been retained by the Oakland Traction Company, and other interested parties to make a new survey for a scenic line from North Berkeley to Grizzly Peak.

NAMPA, IDAHO.—Citizens of this place and Caldwell, Idaho, are on record as favoring the construction of the electric railroad between this place and Caldwell projected by W. E. Pierce of Boise. The right of way has been practically secured, and work will soon be started.

NEW WESTMINSTER, B. C.—The British Columbia Electric Railway Company will start work on the construction of an electric line to the Fraser river mills as soon as plans are approved by the City Council. The same company will soon start work on another line in this city.

BURLINGAME, CAL.—Ansel M. Easton has made application to the Board of Trustees for a franchise for a street railroad, and it is the intention of the board to grant this to the highest bidder. Sealed bids will be received by the clerk up to July 24th for the sale of the franchise.

OAKLAND, CAL.—The Southern Pacific Company has filed with the City Council formal application for permission to electrize its lines east of Fallon street to the boundary line of Oakland under its plan to change all its steam lines to an electric system, at a cost in the neighborhood of $10,000,000.

LODI, CAL.—The Board of Trustees has passed an ordinance granting to the Central California Traction Company a franchise of 47 years, to put in a single track, standard gauge line for the transportation of both freight and passengers, to be run by electricity, along certain highways in the county of San Joaquin.

WENATCHEE, WASH.—The City Council has granted a franchise to the Wenatchee Traction Company for the construction of an electric railway over the city streets. The company deposited a sum of $5000 guaranteeing that the first unit covering Wenatchee avenue will be completed in 18 months, and the second unit within two years.

WOODLAND, CAL.—The Vallejo & Northern Railroad has presented an application to the City Trustees for a franchise for its line over the main street of this city. The company is to begin construction work in a very short time on its air line between here and Sacramento, as its bridges across the Sacramento River will be completed by autumn. The Vallejo & Northern will connect with the Northern Electric at Sacramento and run to Vallejo via Winters, Vacaville and Suisun. A steamer line will connect it with San Francisco.

SACRAMENTO, CAL.—With the completion of the Northern Electric Company's new bridge now being built across the Sacramento River at the foot of M street, will come the extension of the company's lines to Woodland. The company has for a year been planning for this extension and another branch to run from Marysville to Colusa. Probably the Colusa branch will be started first, but it is assured, practically, that the Woodland extension will be commenced during the present year and probably be completed by the middle of next March. The company will not, for a year, build the line from Chico to Red Bluff.

LOS ANGELES, CAL.—The Southern Pacific and Salt Lake lines are to be merged with the Pacific Electric in Long Beach, according to authentic reports. The southern division of the trolley system is to dominate the united roads, and material for electrifying the steam lines is understood to have been already ordered. The merger will give the three roads absolute control of the inner harbor traffic, as the Pacific Electric owns a belt line around that harbor that joins with the city's railway leading to and on the municipal docks. Expenses will be lessened. This may lead to the landing of Southern Pacific steamships at Long Beach instead of San Pedro, as passengers landed at Long Beach can be transported here quicker than they can be carried from San Pedro. It is stated that 30 minutes can be saved in this way. The Pacific Electric will obtain control of 2.90 miles of the Southern Pacific and 5.60 miles of the Salt Lake road, a number of side tracks and spurs, and also several freight yards. The Pacific Electric bought a depot site to the right of the pier entrance. The Iaqua, a schooner carrying 230,000 feet of redwood lumber, docked at the Long Beach city wharf last Friday, being the first vessel to do so.

TELEPHONE AND TELEGRAPH.

NAPA, CAL.—W. M. Lyons has made application for a franchise for a period of 50 years for a telephone line along the public roads in the county of Napa. Sealed bids will be received for the sale of said franchise at the office of the clerk of the Board of Supervisors up to July 11, 1911.

UKIAH, CAL.—Hugh Coy has petitioned the Board of Supervisors for permission to erect poles and string wires and maintain same for telephone purposes. The line is to extend from the southwest corner of the race track one mile south of Ukiah, south along Ukiah and Hopland road. The petitioner was granted permission.

UKIAH, CAL.—The Willits and Laytonville Telephone & Telegraph Company has made application to the Board of Supervisors for permission to erect poles and string wires and maintain same for telephone purposes from the lower end of Long Valley to Willits, over the right of way of the new county road. The permission was granted.

WATERWORKS.

TACOMA, WASH.—The council has authorized the water superintendent to lay 400 feet of pipe on Cascade avenue.

OAKDALE, CAL.—Last Saturday Oakdale voted 217 to 42 for a waterworks, which means that fire protection will be extended to all, and by a vote of 213 to 28 a sewer system was made possible.

SEATTLE, WASH.—A special water bond election held in Snohomish resulted in favor of a $110,000 issue. Superintendent Miley of the Atlas Construction Company of Everett will at once start work.

REDMOND, ORE.—The Council has awarded to the firm of Jeffery & Bufton, contractors of Portland, a contract for the proposed waterworks system from Cline Falls to this city on their bid of $24,500.

SAN FRANCISCO, CAL.—The Spring Valley Water Company is to erect a pumping station at Lake Merced, on the corner of 23d avenue and Sloat boulevard. Plans have been prepared by Engineers L. Winther and H. Monett and are now being figured.

SALT LAKE CITY, UTAH.—Sealed bids will be received at the office of the Board of Public Works up to June 30th, 1911, for the work of constructing waterways at the intersection of Second South and Seventh East streets, according to plans and specifications on file in the City Engineer's office.

SAN FRANCISCO, CAL.—Treasurer McDougald has sold to the Western Metropolis National Bank $14,000 worth of the Sierra water supply bonds, the purchase being made by the bank for a client. The price paid was that under which all the treasurers' sales are made, par and accrued interest.

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PRECIPITATION AND ALTITUDE IN THE SIERRAS

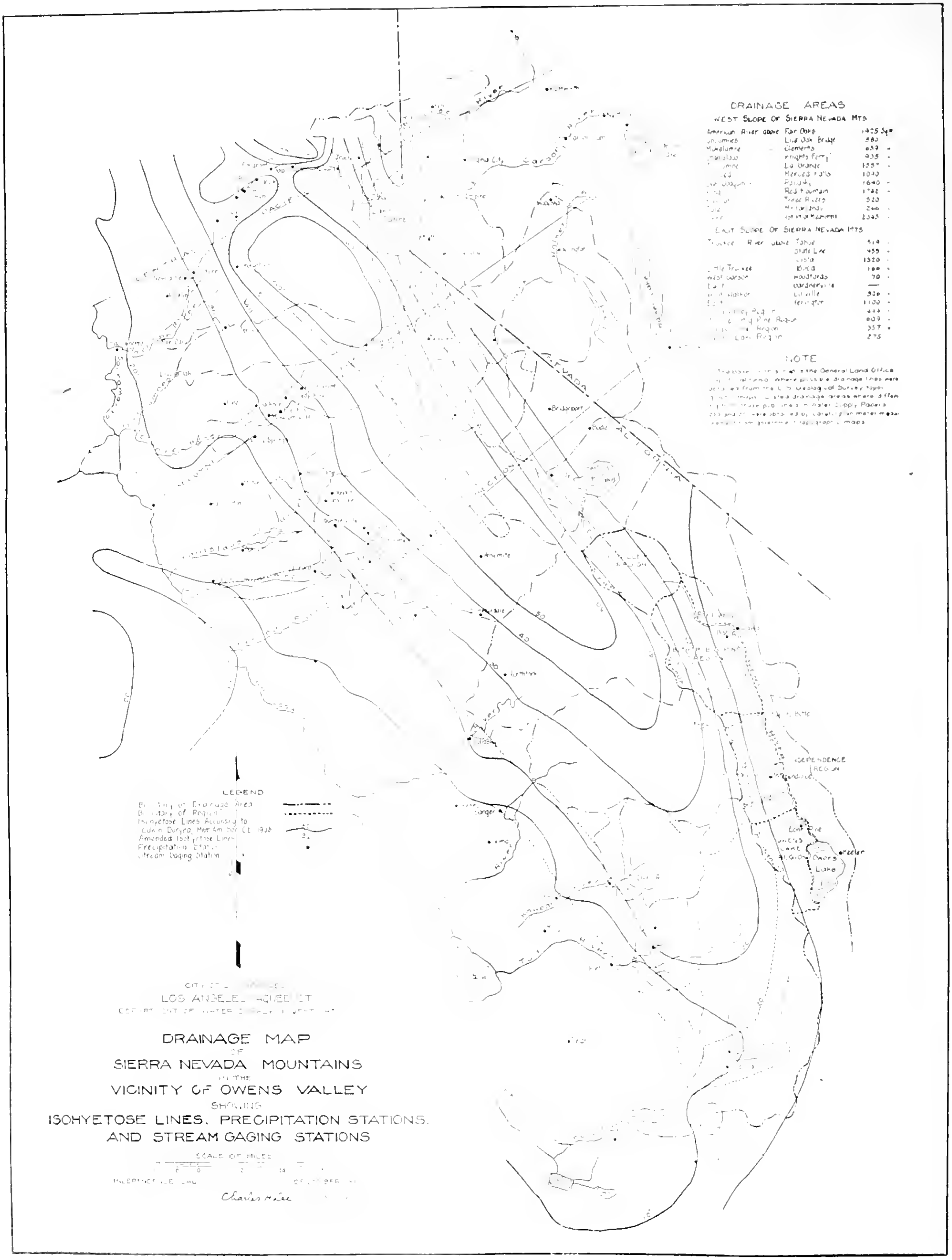
BY CHARLES H., LEE.

Precipitation studies made by the Los Angeles aqueduct in connection with a general investigation of water-supply conditions in the Owens Valley have led to some interesting results regarding the relation of precipitation and altitude in the Sierra Nevada

The High Sierras

Mountains. The portion of the range considered extends from Lake Tahoe to the Mojave Desert. Data gathered and published by the U. S. Weather Bureau were used where available, and were supplemented on the east slope of the Sierra, adjacent to the Owens Valley, with records kept by the aqueduct. The investigations were carried on by the writer under the direction of William Mulholland, chief engineer of the Los Angeles aqueduct.

The phenomenon of the increase of precipitation with altitude is fully recognized by hydraulic engineers who have had occasion to investigate the subject of precipitation. As a basis for engineering computations the relation is often assumed to be a simple ratio, which may be applied without regard to any factor but difference of elevation. As a matter of fact however topography, prevailing winds, latitude and conditions of the atmosphere have a marked effect upon the geographic distribution of rainfall as well as altitude. The straight line relation, even when used as a convenient approximation has a limited use and should not be employed indiscriminately, as is shown by the studies herewith presented.


DRAINAGE AREAS
WEST SLOPE OF SIERRA NEVADA MTS
American River above Fair Oaks 1925 Sq. M.
Mokelumne Clements 637
Knights Ferry 935
La Grange 1559
Merced Falls 1040
Red Mountain 1742
Three Rivers 520
266
2345
EAST SLOPE OF SIERRA NEVADA MTS
Tahoe 519
State Line 455
1520
Little Truckee Boca 166
West Carson Woodfords 70
Gardnerville
506
1100
609
357
275
NOTE
LEGEND
Amended Isohyetose Lines
LOS ANGELES AQUEDUCT
DRAINAGE MAP
SIERRA NEVADA MOUNTAINS
IN THE
VICINITY OF OWENS VALLEY
ISOHYETOSE LINES, PRECIPITATION STATIONS
AND STREAM GAGING STATIONS
SCALE OF MILES
Bridgeport
Owens Lake
Keeler
NEVADA
Lone Pine
Sanger
Independence
50
40
30

The general area within which precipitation data was considered is shown by the accompanying map (Plate 1) of the southern Sierra. Upon this are indicated the principal rivers and their drainage areas, stream gaging and precipitation stations, and isohyets or lines of equal annual rainfall. The isohyets represented by solid lines are those of the Water and Forest Association as amended in 1908 by Edwin Duryea Jr. The dotted isohyets in the southeastern portion of the area are revisions proposed by the writer based on all data available to date. The southern and eastern extension of the 30-inch and 20-inch isohyets is the most radical change and is justified by the aqueduct observations in Owens Valley.

The relations of precipitation and topography are shown in a general manner by the position of the isohyets. A more instructive method is by graphical study of observations made in and near cross sections of the Sierra laid out at right angles to the trend of the range. Five such were chosen and are shown on the map as the Central Pacific, Mokelumne, Taboose, Oak and Bairs sections. There are sufficient observation stations along the two most northerly of these to indicate the relations upon both slopes of the range, but records applying to the three southerly sections are confined to the east slope.

A list of stations along the Central Pacific and Mokelumne sections is given on Table 1, together with elevation, distance from the Great Valley, length of record, observed and computed mean seasonal precipitations and observed precipitation during the season 1909-10. The stations selected were all within twelve miles of the sections and their elevations were such that they lay in the average profile of ground surface. (See Diagrams 3 and 6). Of stations in the Central Pacific group, Sacramento, Newcastle, Iowa Hill, Reno (1888-89 to 1909-10) and Wadsworth (1890-91 to 1909-10) are maintained by the Weather Bureau. Observations at other stations are made by agents of the Central Pacific Railway. Stations in the Mokelumne group are all maintained by the Weather Bureau. Elevations are those published in Weather Bureau reports and where possible were compared with those given on Government topographic sheets. Distances from the Great Valley were scaled from the Government topographic sheets or from the general land office map of California. Observed mean seasonal precipitation was computed for the season September 1 to August 31. The observed means are for periods of differing length and to obtain values more strictly comparable the records were computed so as to apply to a single definite period. That selected for the Central Pacific Group extended over the forty seasons 1870-71 to 1909-10, and for the Mokelumne group the 28 seasons 1882-3 to 1909 10. The method of correcting a short record was the common one of comparison with an adjacent station having a complete record.

Stations in the Taboose, Oak, and Bairs groups were established and maintained by the aqueduct. They are listed on Table 3 with elevation distance from Sierra crest, observed and computed mean seasonal precipitation. The gages were located on or near the sections at the approximate crossings of 500 foot contours. The immediate surroundings were selected with respect to accessibility from roads and trails and the recognized requirements for good exposure were

TABLE 1.

DESCRIPTION AND MEAN PR[illegible] FOR STATIONS IN CENTRAL PACIFIC GROUP.

No. of Gage	STATION	Elevation above sea level Feet.	Distance from Sacramento. Miles.	Length of record [illegible]	[illegible]	Computed Mean Seasonal Precipitation: Base Station	No. Years Corrected	Precipitation Inches	Observed precipitation 1909-10. Inches
1	Sacramento	71	0	61		Sacramento	40	19.36	12.18
2	Rocklin	249	18.9	8	[illegible]	Auburn	40	21.6[illegible]	21.06
3	New Castle	956	26.3	15	[illegible]	Auburn	40	28.20	26.92
4	Auburn	1363	36.0	30	[illegible]	Auburn	40	34.9[illegible]	36.12
5	Colfax	2421	4[illegible]	10	[illegible]	Colfax	40	49.01	49.69
6	Iowa Hill	2825	[illegible]	31	[illegible]	Colfax	[illegible]	50.[illegible]	50.68
7	Gold Run	3222	[illegible]	1[illegible]	[illegible]	Alta-Towle	[illegible]	[illegible]	48.34
8	Towle (Alta)	3612	[illegible]	[illegible]	[illegible]	Alta-Towle	[illegible]	[illegible]	53.02
9	Blue Canyon	4695	[illegible]	[illegible]	[illegible]	Alta-Towle	[illegible]	[illegible]	64.11
10	Emigrant Gap	5230	[illegible]	30	[illegible]	Cisco	[illegible]	[illegible]	56.28
11	Cisco	5939	67.9	40	[illegible]	Cisco	40	[illegible]	58.85
12	Summit	7017	78.6	39	[illegible]	Cisco	[illegible]	[illegible]	37.00
13	Truckee	5820	85.8	39	[illegible]	Truckee	[illegible]	[illegible]	25.01
14	Boca	5531	90.0	38	[illegible]	Boca	[illegible]	[illegible]	25.93
15	Reno	4484	110.1	39	[illegible]	Reno	[illegible]	7.95	7.52
16	Wadsworth (Fernley)	4084	138.4	35	[illegible]	Wadsworth	[illegible]	[illegible]	[illegible]

Stations 1 to 12 inclusive, Seasonal totals (S[illegible] Aug. 31)
Stations 13 to 16 inclusive, Calendar [illegible] (First edition)

TABLE 2.

DESCRIPTION AND MEAN PREC[illegible] FOR STATIONS IN MOKELUMNE GROUP

No. of Gage	STATION	Elevation above sea level Feet.	Distance from Stockton. Miles.	Length of record [illegible]	[illegible] Inches	Computed Mean Seasonal Precipitation: Base Station	No. Years Corrected	Precipitation Inches	Observed precipitation 1909-10. Inches
1	Stockton	23	0	60	[illegible]	Stockton	[illegible]	14.82	13.81
2	Farmington	111	13.0	[illegible]	[illegible]	Farmington	[illegible]	16.73	15.91
3	Ione	287	33.0	[illegible]	[illegible]	Ione	[illegible]	21.33	20.39
4	Valley Springs	673	31.2	[illegible]	[illegible]	Stockton	[illegible]	[illegible]	23.28
5	Jackson	1200	40.0	20	[illegible]	Jackson	[illegible]	[illegible]	.....
5	Mokelumne Hill	1550	41.0	[illegible]	[illegible]	Mokelumne Hill	[illegible]	[illegible]	32.93
7	West Point	2800	52.8	15	[illegible]	Mokelumne Hill	[illegible]	41.15	39.56
8	Bear Valley Res.	5800	72.5	[illegible]	[illegible]	Mokelumne Hill	[illegible]	57.65	.....
9	Tamarack	8012	89.5	11	[illegible]	Mokelumne Hill	[illegible]	54.73	48.94
10	Gardnerville	4830	108.5	11	[illegible]	Mokelumne Hill	[illegible]	9.08	16.57
11	Wabuska	4347	111.5	[illegible]	[illegible]	———	....	.....	3.49

TABLE 3.

PRECIPITATION STATIONS IN OWEN VALLEY.

Number of gage	GROUP	Elevation above sea level. Feet.	Distance from crest of Sierra Nevada Mts. Miles.	Observed Precipitation in Inches: Season 1908-9	Observed Precipitation in Inches: Season 1909-10	Computed mean seasonal precipitation based on 26 yr. record at Independence.
2	Taboose	4070	8.1	9.09	6.65	6.56
3	Taboose	4460	6.9	10.40	7.61	7.51
4	Taboose	5040	5.5	11.74	8.69	8.53
5	Taboose	5550	4.7	16.53	9.26	10.48
6	Taboose	6190	4.2	23.24	12.94	14.69
18	Oak	3735	13.8	....	3.15	3.25
17	Oak	3775	12.5	....	4.25	4.38
7	Oak	3940	9.6	7.22	4.45	4.78
8	Oak	4300	8.4	9.24	....	6.37
8A	Oak	4500	8.0	....	5.27	5.43
9	Oak	5030	6.6	11.35	6.42	7.22
10	Oak	5590	5.7	14.47	7.67	8.94
11	Oak	6120	4.8	21.04	10.19	12.51
12	Bairs	4100	10.2	4.28	3.74	3.40
13	Bairs	4500	9.0	6.09	3.63	3.97
14	Bairs	5000	7.7	7.63	5.34	5.38
15	Bairs	5500	6.6	11.67	5.94	7.08
16	Bairs	6100	5.7	14.34	7.24	8.68

observed. The highest level on the slope of the Sierra which can be reached from the Owens Valley after the winter snow storms is approximately the 6500 foot contour. Gages were distributed between this contour and the valley floor, which near Independence has an average elevation of 3800 feet. The type of gage used was the ordinary 8-inch cylindrical gage of the Weather Bureau. The funnel shaped receiver, however, was dispensed with so that the catch fell directly into the 8-inch cylinder. The mounted observer carried the inner tube and cedar measuring stick and poured the catch from the container into the small tube for measurement. Snow was reduced to equivalent water by weighing the catch with a spring balance. The gages were visited after each storm, an observer being detailed to each group. Snow shoes were part of the necessary equipment in winter. The exact elevation and location of the gages was determined by ordinary engineering methods. Distances from the Sierra crest were scaled from the Mt. Whitney Quadrangle of the U. S. Geological Survey. The 26-year record at Independence which was used as a basis for computing long term means is given in Table 4. The portion of this record from September, 1866 to August, 1877, was obtained under the direction of U. S. Army

CENTRAL PACIFIC GROUP OF PRECIPITATION GAGES

DIAGRAM Nº 1 - RELATION OF ALTITUDE AND PRECIPITATION

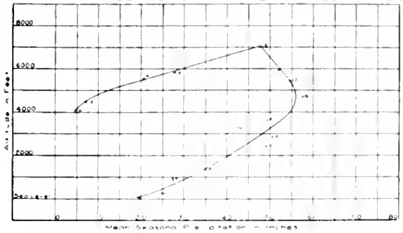
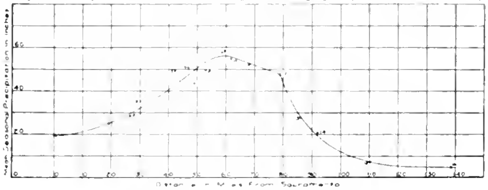
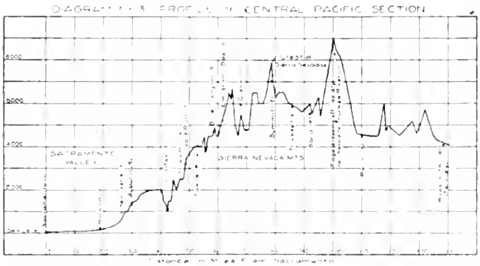


DIAGRAM Nº 2 - RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION





officers stationed at Fort Independence. It was obtained under conditions sufficiently similar to permit of its being combined with the more recent Weather Bureau record at the present town of Independence.

The relations of precipitation, altitude and topographic position, and also profiles of ground surface

TABLE 4.

PRECIPITATION IN INCHES AT INDEPENDENCE, CAL.

1865-1877, U. S. War Department, Fort Independence. Elevation 3930.

1892-1895, and 1898-1910, U. S. Weather Bureau, Independence. Elevation 3920.

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
1865-6	....	....	0	0.65	2.42	0	0	0.16	....	....	....	....	.....
1866-7	0	0.32	0	2.27	0	1.63	4.76	0.53	0.76	0	0.01	1.15	11.43
1867-8	0.07	0.32	0.21	12.19	5.46	0	0	0.40	0.71	0	0.10	0	19.46
1868-9	0	0.74	0.44	1.17	0.16	0	0.32	0.11	0.36	0	0.03	0	3.33
1869-0	0	0	0.14	0	0.20	1.36	0	0.21	0.27	0	0.35	0.10	2.63
1870-1	0	1.10	0	1.00	0	1.28	0	0	0	0.30	0	0	3.68
1871-2	0	0	0.65	4.70	0	0.30	0.28	0.55	0.15	0	0.28	0.12	7.06
1872-3	0	0	0	1.18	0	0.40	0	0	0	0	0	0.05	1.63
1873-4	0.10	0	0	3.40	2.40	1.00	0	0	0	0.01	0.15	0	7.06
1874-5	0.40	0.80	0.40	0	1.73	0	0	0	0	0	0	0	3.33
1875-6	0.01	0	0.66	0.62	1.51	0.70	0.87	0	0	0.15	0.19	0.56	5.27
1876-7	0.16	0.26	0	0	0.76	0	0	0.59	0.69	0	0	0	2.46
1891-2	....	....	....	....	....	....	0.62	....	0.96	0.07	T	T	.....
1892-3	0	0.35	0.23	1.61	1.51	2.91	0.98	0.02	T	0	0.77	T	8.38
1893-4	T	0	0.10	0.75	0.12	0.42	0.09	0.02	0.10	0.11	0.12	0.51	2.34
1894-5	T	0	0	1.89	1.24	1.18	0.12	T	0.01	T	T	0.04	4.48
1895-6	T	0.83	0.67	0.08	1.67	0	....	....	....	....	....	....	....
1896-7	....	....	....	....	....	....	....	....	....	....	....	....	....
1897-8	....	....	....	....	....	....	0	0.16	0.23	T	T	0.11	....
1898-9	0.20	0	0.10	0.20	0.54	T	0.01	0.02	0.03	0.37	0.01	0.06	1.54
1899-0	T	0.30	0.85	0.56	0.31	0.05	0.67	0.62	0.22	0.04	0.08	T	3.70
1900-1	0.75	0.01	1.34	0.13	2.81	0.64	0.05	T	0.36	0	0.10	0.32	6.51
1901-2	0	0.65	0.22	0.06	0.04	1.69	1.05	0.17	0.04	0.01	0.17	0.13	4.23
1902-3	T	0.08	0.41	0.04	0.71	0.27	0.34	0.19	T	0.02	0	0	2.06
1903-4	T	0.42	T	0	T	1.20	0.95	T	0.02	0	T	0.07	2.66
1904-5	0.32	0.06	0	T	0.54	0.73	2.08	T	0.25	0	0	T	3.98
1905-6	0.27	0	0.43	T	2.89	0.13	1.86	0.36	0.42	0.10	0.31	0.04	6.79
1906-7	0	0	0.02	0.84	0.95	0.56	1.10	0.14	0.01	0.55	T	0	4.17
1907-8	0	2.12	T	0.12	1.63	0.98	0.14	T	T	T	0.26	0.46	6.01
1908-9	0.84	0.03	0.01	0.20	2.27	2.73	0.16	0.12	T	T	0	0.25	7.61
1909-0	0.07	0.01	0.19	3.90	0.25	T	0.10	0.31	0	0	0.27	0	5.10
26 year. Mean	0.12	0.29	0.25	1.43	1.12	0.77	0.61	0.17	0.17	0.06	0.12	0.15	5.26

based on U. S. Geological Survey topographic maps are shown for each of the accompanying charts. The values represented by numbered points are those given in Tables 1, 2 and 3. The points at the upper end of curves for Taboose, Oak, and Bairs sections need further explanation however. As previously noted it was not practical to make complete precipitation observations above the 6500 foot contour in Owens Valley. An attempt has been made however to arrive at approximate values for precipitation along the adjacent Sierra crest from computations based on measured stream flow. Data available were the true run-off from the east slope of the Sierra measured at mouths of canyons, and an approximate value of the run-off factor. The mean seasonal discharge per square mile of mountain drainage areas crossed by the Taboose and Oak sections is 1.75 sec. ft., and by the Bairs section [illegible] sec. ft. The run-off factor for Kings River, which is adjacent to Owens Valley drainage on the west, is 0.59. Computations for the latter are based on the isohyets of Plate 1; observed variation in precipitation at Merced, Fresno, Sanger, Selma, Visalia and Summerdale; and discharge measurements of Kings River at Red Mountain covering 20 seasons. Run-off factors for the small drainage areas tributary to Owens Valley are probably larger than for Kings River for the following reasons: the greater average elevation of drainage areas tributary to Owens Valley; non-porous character of the granite bed-rock; the universal occurrence of deep cirques and canyons which favor the collecting of snow in protected drifts; the snow dust carried over the Sierra crest into the cirque basins by prevailing west and northwest winds; and the absence of lake surfaces or extensive areas supporting vegetation. All of these characteristics tend to make the run-off greater than for Kings River by decreasing evaporation and percolation losses. A value of 0.75 is thought to correctly represent run-off conditions for the Owens Valley streams.

The shape of many of the mountain drainage areas tributary to the Owens Valley is that of an isosceles triangle with apex at canyon mouth and base lying along the Sierra crest. Measuring from the Sierra crest

MOKELUMNE GROUP OF PRECIPITATION GAGES.

DIAGRAM No. 4 RELATION OF ALTITUDE AND PRECIPITATION

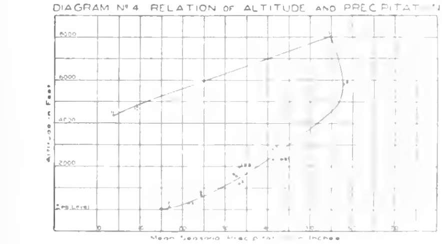


DIAGRAM No. 5 RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

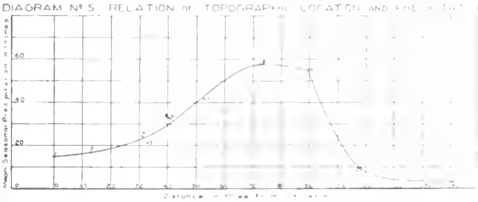
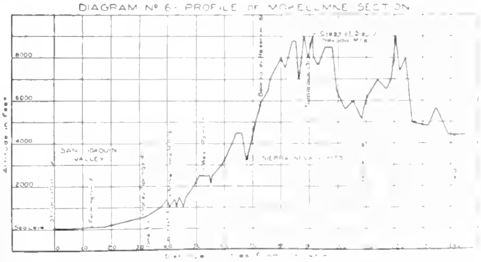


DIAGRAM No. 6 PROFILE OF MOKELUMNE SECTION



TABOOSE GROUP OF PRECIPITATION GAGES

DIAGRAM No. 7 - RELATION OF ALTITUDE AND PRECIPITATION

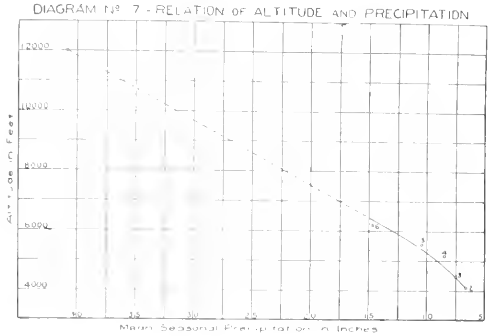


DIAGRAM No. 8
RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

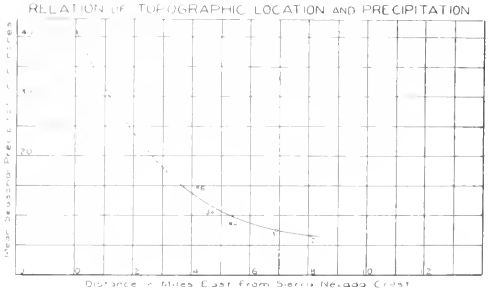
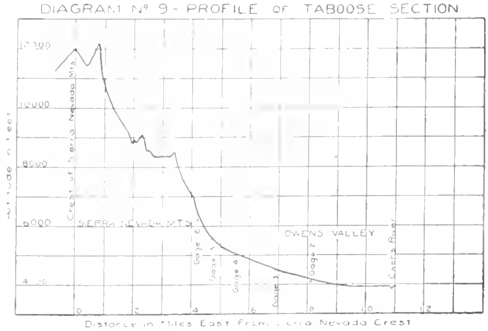


DIAGRAM No. 9 - PROFILE OF TABOOSE SECTION



OAK GROUP OF PRECIPITATION GAGES

DIAGRAM Nº 10 - RELATION OF ALTITUDE AND PRECIPITATION

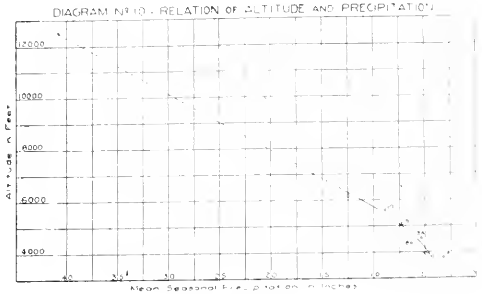


DIAGRAM Nº 11
RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

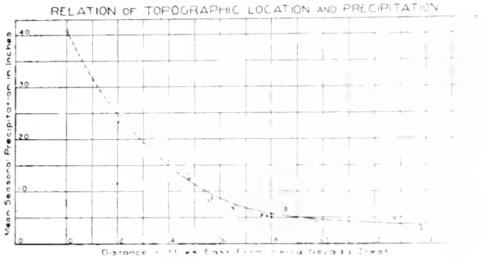
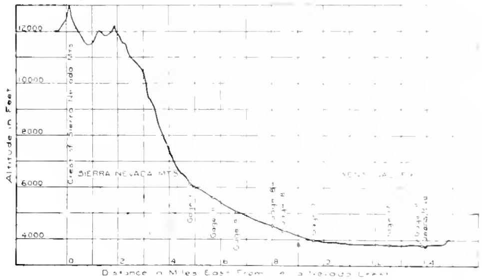


DIAGRAM Nº 12 PROFILE OF OAK SECTION



BAIRS GROUP OF PRECIPITATION GAGES.

DIAGRAM Nº 13 - RELATION OF ALTITUDE AND PRECIPITATION

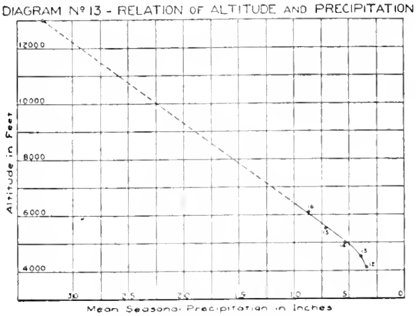


DIAGRAM Nº 14
RELATION OF TOPOGRAPHIC LOCATION AND PRECIPITATION

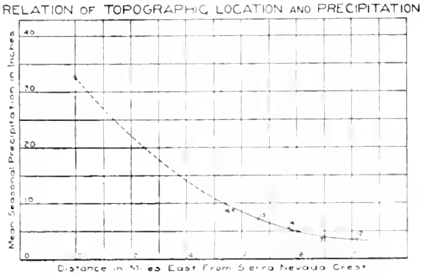
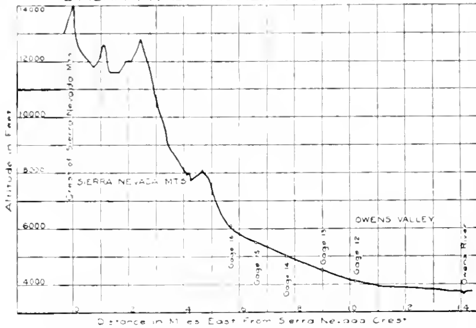


DIAGRAM Nº 15 - PROFILE OF BAIRS SECTION



and assuming a uniform rate of change of precipitation from crest to canyon mouth, as indicated by the observations in the Central Pacific and Mokelumne sections, the average precipitation over one of these triangles equals the true precipitation at one-third the distance between these two points. The observed precipitation at canyon mouths being available it is therefore a matter of simple proportion to compute that at the crest. The average depth of precipitation over drainage areas having run-off factors of 0.75 and discharges per sq. mi. of 1.75 and 1.36 sec. ft., is 31.7 and 24.6 ins. respectively. Employing the method of computation outlined above, the values for precipitation at the Sierra crest are 40.8 ins. for the Taboose and Oak sections and 32.7 for the Bairs section. These are the points not numbered on Diagrams 7, 8, 10, 11, 13, and 14.

The study of the data presented in Tables 1, 2 and 3 involves a graphical analysis of the relation of (1) precipitation to altitude and (2) horizontal position to precipitation in connection with topography. See Diagrams 1, 4, 10, 13 and Diagrams 2, 3, 5, 6, 8, 9, 11, 12, 14, 15). In general the shape of the curves which fit the platted points is similar throughout each set of diagrams. Examining the precipitation and altitude curves in detail it appears that there is an increase of precipitation with altitude from the floor of the Great Valley up the western slope of the Sierra to about the 5000 foot level. The rate of increase for this portion of the curve is greatest in the lower foothills and steadily decreases with increase of elevation. Above 5000 feet there is a moderate decrease in precipitation with increase of altitude, the rate being practically constant. East of the Sierra crest precipitation decreases rapidly with decrease in altitude, maintaining a constant rate to the 5000 foot level and a decreasing rate below this elevation. The distance and precipitation curves conform to the profile in general shape, except that their maxima are west of the topographic crests, occupying the same relative position with respect to the

Great Valley as the 5000 foot level. They have a tendency to become horizontal over the level portions of the profile to rise over western slopes below the 5000 foot contour, fall over western slopes above this contour, and to fall over eastern slopes. In other words the general slope of the country seems to have more to do with the amount of precipitation than does altitude.

Precipitation upon the plains of northern India and the southern slope of the Himalaya Mountains exhibits a similar variation. An emperical equation giving the relation of precipitation and elevation has been developed from observations in that region as follows: $R = 1 + 1.92h - 0.40h^2 + 0.02h^3$ in which R represents the amount of rain and h the relative height in units of 1000 feet above an assumed plane which was itself 1000 feet above sea level. The critical elevation was 4160 feet above sea level and observations were sufficient to determine that the form of the curve above this elevation was similar to that below, the complete curve approximating a cubic parabola whose axis is the line represented by the critical elevation. The curves on Diagrams 1 and 4 suggest a similar relation for the west slope of the Sierra, with a critical elevation of about 5000 feet. The relatively low crest of the latter range, however, breaks the relation just above the critical elevation so that the upper arm of the curve is incomplete, and a discontinuity is introduced. The relation of precipitation to elevation upon the Sierra Nevada are therefore not unique but conform to some general law.

The condition met with is the broad slope of a long mountain range presented to a prevailing moisture laden wind. The movement of a body of moist air up such a slope results in expansion and cooling of the air. When the temperature reaches the dew point condensation of the aqueous vapor occurs. The latent heat thus liberated tends to warm the air and raises its temperature above the dew point. The descent of the leeward slope of the range is accompanied by rapid compression and rising temperature of the body of air. Hence precipitation is greatest along the lower windward slopes of the Sierra, reaching its maximum at the lower cloud limit at the 5000 foot contour, decreases slowly from here to the crest of the range, and decreases rapidly down the leeward slope to the desert. It is therefore not increasing elevation alone which causes increase in precipitation, but broad rising slopes which give an upward movement to bodies of moist air driven by prevailing winds.

The conclusions form this study which can be applied in practical computations are as follows:

(1) The precipitation upon the west slope of the Sierra between the Yuba and Tuolumne Rivers increases at a variable rate which expressed as an average is 0.85 inches per 100 feet rise between the floor of the Great Valley and the 5000 foot contour.

(2) Above the 5000 foot contour it decreases approximately at the rate of 0.40 inches per 100 feet rise to the crest of the Sierra.

(3) Precipitation upon the east slope of the Sierra decreases at differing rates depending on the elevation of the crest and depth of precipitation at the summit. The rate is constant above the 5000 foot contour and for the sections studied is as follows: Central Pacific 1.74 ins. per 100 feet fall, Mokelumne 1.43 ins. per 100 feet fall, Taboose and Oak 0.46 ins. per 100 feet fall, and Bairs 0.34 ins. per 100 feet fall.

NEW SPECIFICATIONS FOR RUBBER COVERED WIRE.

In response to a number of requests we publish the new specifications for rubber covered wire (0-600 volts) recently issued by the National Board of Fire Underwriters. These have already been adopted in New York City and in Chicago and will soon be required in several Pacific Coast cities. A stock of wire meeting these requirements is now being carried on the Coast, so that contractors and others can comply with these rulings:

Rule 40 (a) Copper for insulated solid conductors of No. 4 B. & S. gauge and smaller must not vary in diameter more than .002 of an inch from the standard. On solid sizes larger than No. 4 B. & S. gauge the diameter shall not vary more than one per cent from the specified standard. The conductivity of solid conductors shall not be less than 97 per cent of that of pure copper of the specified size.

In all stranded conductors the sum of the circular mils of the individual wires, shall not be less than the nominal circular mils of the strand by more than one and one-half per cent. The conductivity of the individual wires in a strand shall not be less than is given in the following table, which applies to tinned conductors:

Number	Per cent.	Number.	Per cent.
14 and larger	97.0	23	95.2
15	96.8	24	95.0
16	96.6	25	94.8
17	96.4	26	94.6
18	96.2	27	94.4
19	96.0	28	94.2
20	95.8	29	94.0
21	95.6	30	93.8
22	95.4		

The standard for diameters and milages shall be that adopted by the American Institute of Electrical Engineers.

(b) Wires and cables designed to meet the following specifications must have a distinctive marking the entire length of the coil so that they may be readily identified in the field. They must also be plainly tagged or marked as follows:

1. The maximum voltage at which the wire is designed to be used.

2. The words "National Electric Code Standard."

3. Name of the manufacturing company and, if desired, trade name of the wire.

4. Month and year when manufactured.

Rule 41. All tests required by this rule shall apply on all wire at the time of manufacture as well as up to and including the time of installation.

(a) Copper for conductors must be thoroughly tinned.

(b) Must consist of rubber or other approved compounds, homogeneous in character, adhering to the conductor, and of a thickness not less than that given in the following table:

B. & S. Gauge.	Thickness	Circular Mils	Thickness
18 to 16	1/32 inch	250,000 to 500,000	3/32 inch
15 to 8	3/64 inch	500,000 to 1,000,000	7/64 inch
7 to 2	1/64 inch	Over 1,000,000	1/8 inch
1 to 0000	5/64 inch		

Measurements of insulating wall are to be made at the thinnest portion of the dielectric.

(c) Every length of completed wire or cable must be tested after ten hours' immersion in water, temperature to approximate 60 degrees, Fahr. (15.5 C.), and results of insulation tests at different temperatures to be reduced to a basis of 60 degrees Fahr. by using factors in the following table:

These tests must be made after an electrification of one minute and with a voltage of not less than 100 volts. Table of Multipliers to Correct Insulation Resistances at Observed Temperatures to Megohms at 60 degrees Fahrenheit.

Temp. Degs. Fahr.	Multi-plier.	Temp. Degs. Fahr.	Multi-plier.	Temp. Degs. Fahr.	Multi-plier.	Temp. Degs. Fahr.	Multi-plier.
85	2.68	76	1.88	67	1.32	58	.92
84	2.58	75	1.81	66	1.27	57	.88
83	2.48	74	1.74	65	1.22	56	.85
82	2.38	73	1.67	64	1.17	55	.82
81	2.29	72	1.60	63	1.12	54	.78
80	2.20	71	1.54	62	1.08	53	.75
79	2.12	70	1.48	61	1.04	52	.72
78	2.04	69	1.43	60	1.00	51	.69
77	1.96	68	1.37	59	.96	50	.66

Voltage tests and minimum insulation resistance to be in accordance with the following table:

TESTS ON COMPLETED LENGTHS R. C. WIRES AND CABLES, 0-600 VOLT CLASS.

Size wire	Voltage test for 1 minute.	Megohms per mile after 10 hours' immersion and after vol. test.			
			4	2000	150
			2	2000	125
14	1500	300	1	2500	150
12	1500	250	1/0	2500	125
10	1500	225	2/0	2500	125
8	1500	200	3/0	2500	100
6	2000	200	4/0	2500	100

Voltage tests and minimum insulation resistance to be in accordance with the following table:

TESTS ON COMPUTED LENGTHS R. C. WIRES AND CABLES, 0-600 VOLT CLASS.

Size	Vol. test for one minute.	Megohms per mile after 10 hrs. immersion and after voltage test			
			700,000 C.M's	3500	100
			800,000 C.M's	3500	100
			900,000 C.M's	4500	100
250,000 C.M's	3000	100	1,000,000 C.M's	3500	100
300,000 C.M's	3000	100	1,250,000 C.M's	3500	100
400,000 C.M's	3000	100	1,500,000 C.M's	3500	75
500,000 C.M's	3000	100	1,750,000 C.M's	3500	60
600,000 C.M's	3500	100	2,000,000 C.M's	3500	50

Any length may be tested after 30 days' immersion in clear water and must show not less than 50 per cent of insulation resistance required after 10 hours' immersion.

(d) Any one foot length of the completed covering must show a dielectric strength sufficient to resist throughout five minutes the application of an electro-motive force proportionate to the thickness of insulation in accordance with the following table.

Thickness in 64ths ins.	Breakdown Test on 1 foot.	Thickness in 64ths ins.	Breakdown Test on 1 foot.
1	3,000 Volts A.C.	7	16,500 Volts A.C.
2	6 000 Volts A.C.	8	18,000 Volts A.C.
3	9,000 Volts A.C.	10	21,000 Volts A.C.
4	11,000 Volts A.C.	12	23,500 Volts A.C.
5	13,000 Volts A.C.	14	26,000 Volts A.C.
6	15,000 Volts A.C.	16	28,000 Volts A.C.

The source of alternating electro-motive force shall be a transformer of at least one kilowatt capacity. The application of the electro-motive force shall first be made at 3000 volts for five minutes and then the voltage increased by steps of not over 3000 volts, each held for five minutes, until the rupture of the insulation occurs. The tests for dielectric strength shall be made on a sample of wire which has been immersed in water for seventy-two hours. One foot of the wire under test is to be submerged in a conducting fluid held in a metal trough, one of the transformer terminals being connected to the copper of the wire and the other to the metal of the trough.

(h) Test for Hardness of Insulation. The rubber or other approved compounds used as an insulation, must, after the braid has been carefully removed, be sufficiently elastic to permit all wires smaller than No. 7 B. & S. gauge to be wrapped at least five times around a cylinder of diameter as specified, and left so wrapped for twenty-four hours without injury to the insulation.

The diameter of cylinder used for any size wire shall be as follows:

Nos. 8, 9 and 10 B. & S. gauge, equal to twice the diameter of wire measured over the insulation, after removing the braid.

No. 11 and smaller, B. & S. gauge, equal to the diameter of wire measured over the insulation, after removing the braid.

Test for Softness of Insulation. The rubber or other approved compounds used as an insulation must present sufficient resistance to crushing or tension to withstand the following two tests:

Samples while being prepared for these tests shall have a temperature between 50 and 90 degrees Fahrenheit and shall be kept within these limits during the tests.

Test A. A sample of wire of sufficient length for test, about 20 inches, shall have the braid and insulation removed for about two inches at each end, leaving the braid and insulation on balance of sample. One end of the bare copper shall be fastened to a clamp on a shaft of the diameter given below, and a ten-pound weight attached to the other bare copper end of the wire. The shaft shall then be revolved ten times in ten seconds, wrapping the sample in a close, even wind around the shaft. With the tension left on the sample, it shall then be immersed in water at a temperature of 60 degrees Fahrenheit for twenty-four hours, immediately after which time it shall, while still immersed, be subjected to 1500 volts alternating current for one minute and shall show an insulation resistance equal to at least half that required by 41-c.

Diameter of Shaft, No. 14 Wire, 170 mils.
Diameter of Shaft, No. 12 Wire, 190 mils.
Diameter of Shaft, No. 10 Wire, 275 mils.
Diameter of Shaft, No. 8 Wire, 375 mils.

Test B. Sample to be tested shall have braid carefully removed for at least one inch from one end. The wire itself shall be connected to one terminal of an electric circuit, of which a testing tool, described in the following paragraph, shall be the other terminal. This circuit shall have a potential of at least 100 volts alternating, or 140 volts direct current and a resistance of at least 1,000 ohms.

The portion of the wire with braid removed shall be placed on a flat surface and subjected to a pressure, vertically applied by means of the edged tool mentioned above, of five pounds for fifteen minutes. The tool edge shall be sharp and the sides of the edge shall form an angle of 90 degrees with each other. During this period the tool edge, when placed transversely to the insulation shall not sink through sufficiently to touch the copper wire and complete the electric circuit.

(i) All of the above insulations must be protected by a substantial braided covering, properly saturated with a preservative compound. This covering must be sufficiently strong to withstand all the abrasions likely to be met with in practice, and must substantially conform to approved samples submitted by the manufacturer.

WEATHER-PROOFED ELECTRIC CABLE FOR CHINA.

A list follows of firms in Shanghai which tendered for 21 miles of water-proofed electric cable for the use of the Shanghai municipal council. The table includes name of manufacturer in most instances and price, which has been converted from sterling quotations at $4.83.

Shanghai firms.—Manufacturer.	Delivery (weeks)	Quotation.
Garrels, Borner & Co.—Felton & Guilleaume....	14	$5,288
Arnhold, Karberg & Co.—Not given............	12	5,540
Anderson, Meyer & Co—General Electric Co.....	15	5,655
Shewan, Tomes & Co—U. S. Steel Products Co...	18	5,723
Siemssen & Co—Bergmann Electrical Works...	16	5,738
W. T. Henley—Henleys, Woolwich	14	5,762
Innis & Riddle—Union Cable Co................	17	5,926
Scott, Harding & Co—British Insulated Co......	13	6,018
Jardine, Matheson & Co—Bergmann Electric Co	18	6,110
Brighten, Malcolm & King—Callenders (Ltd)....	14	6,549
Siemens China Electric Co.—Siemens Bros. & Co.	15	6,844
Melchers & Co.—Cassierer & Co...............	12	6,882

STEAM SHOVEL FOR DITCHING.

A number of types of machines have been devised for ditching, trenching, canal building, etc., but in most cases their use has been limited to low flat lands where large quantities of earth were to be moved cheaply, or in cities where water gas or sewer pipes were to be laid at some distance below the ground surface. The most universal machine of this character, suitable for the heaviest sort of work and which may be used in almost any sort of working is the well known steam bucket shovel.

For all sorts of railroad work the steam shovel has long been found indispensable, but it is within only the last few years that so radical a use has been made as to build mountain roads or to construct large power or irrigation canals in the rugged mountain section of the West. The cost of mountain roads is necessarily high and when the road is through an inaccessible region, where it is difficult to procure labor, where all supplies must be hauled many miles and where the excavation consists largely of large boulders or solid rock, hand road making becomes almost impossible.

The first thought in the use of a steam shovel for this work is the cost of the apparatus and then the

Ditch Digging with a Steam Shovel.

cost and difficulty of transportation from the nearest railroad station to the point many miles away where the work is to commence. This is of course the principal part of the first cost. The results of work of this kind in the Kings river canyon in California were most important, in that the shovel once on the road was found to operate satisfactorily, moving or rolling the large boulders, stumps and logs with ease and all other rock left from blasting. The cost of this road, including the cost of the shovel was but 50 per cent of the cost of hand labor previous to the use of the shovel and the rapidity of construction several times greater. For work of this sort there might be some districts where the question of fuel would be difficult of solution, but in most cases fuel is near at hand or easily procured.

The most important work which the steam shovel has accomplished, however, in the mountain sections is in the construction of earth canals of large capacity. This work is now being done in California and elsewhere on a large scale and the results are most gratifying. An earth canal following a mountain side and having capacity for 300 to 500 second ft. flow represents a large amount of excavation. To do this by hand work is more costly per yard of excavation than it would be in a small canal of say 50 second ft. This is because earth must be handled more than once due to the depth of the cut and the height of the dump

Ditch Excavated by Steam Shovel.

bank. In any case the cost including the blasting which may be necessary can easily amount to a figure that might make a project, as an investment, unadvisable. The steam shovel is admirably suited for such work and the ease and certainty of operation, even where the ground excavated must be blasted, makes this method of carrying large quantities of water economical and advisable in some localities. The cost of canal built in this manner is from one-half to one-third the cost of hand work; it, as in road making, is much more rapid and the amount of blasting and the resulting shaking of the canal walls is less, thus insuring a more permanent structure. The shovel does not leave the canal in a finished condition as in some of the special trench excavators, hence there is always necessity for trimming and cleaning up. But the principal object is best accomplished with this machine, that of excavation.

THE COST OF CONCRETE AT PANAMA.

There is a slight increase in the cost of concrete at the Pedro Miguel Locks due to a smaller yardage, consequent upon a portion of the construction plant having been moved to the locks at Miraflores. The cost of \$5.2131 per cu. yd. for the quarter is, however, below the estimate of \$8.25 a cu. yd. made in October, 1908. At Miraflores, although only a part of the construction plant was in operation, 70,087 cu yds. of concrete were produced during the quarter at an average cost of \$4.8434 a yard, as compared with \$8.22 a yard, the estimate of October, 1908.

PROPERTIES AND USES OF DOUGLAS FIR.

In Bulletin 88 of the Forest Service Mr. Garvey Kline and J. B. Knapp present the facts about the mechanical properties and uses of Douglas fir which have been collected by the Forest Service. It may, perhaps, be considered as the most important of American woods. Though in point of production it ranks second to southern yellow pine, its rapid growth in the Pacific Coast forests, its comparatively wide distribution, and the great variety of uses to which its wood can be put place it first. Estimates of the available supply range from 300,000,000,000 to 350,000,000,000 feet board measure. It is extensively used in the building trades; by the railroads in the form of ties, piling, car, and bridge material; and by many of the manufacturing industries of the country. As a structural timber it is not surpassed, and probably it is most widely used and known in this capacity. The species is most abundant and attains its largest size not far above the sea level in southern British Columbia and in the region between the coast of Washington and Oregon and the western foothills of the Cascade Mountains. Here large trees crowded close together rise to a height of from 200 to 300 feet, forming, either alone or mixed with hemlock, very dense forests that yield from 35,000 to 60,000 board feet per acre and sometimes as much as 100,000, and in one recorded instance 500,000 feet.

The wood is strong and hard, not very heavy, and fairly durable. These qualities particularly recommend it for structural purposes. The grain is straight. The spring and summer wood vary greatly in density; the spring growth is soft and spongy and almost white in color, while the summer wood is hard and flinty and very dark. The grain varies from as few as four or five rings to the radial inch to as many as forty-five.

In the eastern part of its range in the Rocky Mountain region, where the rainfall is not abundant and where extremes of climate occur, the trees are much smaller, rarely over 1½ ft. in diameter and over 90 ft. high. In this section the stand ranges from 2000 to 8000 board ft. per acre.

Douglas fir is known by various names in different sections of the country. The most common names and the States in which they are used are:

Douglas fir (Utah, Oregon, Colorado, Washington).

Red fir (Oregon, Washington, Idaho, Utah, Montana, Colorado).

Douglas spruce (California, Colorado, Montana).

Yellow fir (Oregon, Montana, Idaho, Washington).

Spruce (Montana).

Oregon pine (California, Washington, Oregon).

Fir (Montana).

Red pine (Utah, Idaho, Colorado).

Puget Sound pine (Washington).

General Results of Tests.

Tests on 8 in. by 16 in. by 16 ft. bridge stringers gave the following average stresses. The likelihood of variations from these averages, due to defects in the timber and to other causes, is discussed under separate headings.

TABLE 1.—RESULTS OF TESTS ON GREEN DOUGLAS FIR BRIDGE STRINGERS.

	Fibre stress at elastic limit, Lbs. per sq. in	Modulus of rupture, Lbs. per sq. in.	Modulus of elasticity 1000 lbs. per sq. in.
Selects:			
Green	4,346	6,753	1,654
Air-dry	4,690	7,070	1,641
Merchantable:			
Green	3,895	5,878	1,481
Air-dry	4,625	6,472	1,567
Seconds:			
Green	3,538	5,188	1,328
Air-dry	3,740	4,551	1,280
All grades:			
Green	4,000	6,000	1,510
Air-dry	4,467	6,327	1,540

The properties of green material as derived from tests on small pieces free from defects as follows:

TABLE 2.—RESULTS OF TESTS ON SMALL CLEAR PIECES OF GREEN DOUGLAS FIR.

	Pounds per sq. in.
Bending:	
Fiber stress at elastic limit	5,500
Modulus of rupture	8,400
Modulus of elasticity	1,600,000
Compression parallel to grain:	
Crushing strength at elastic limit	3,600
Crushing strength modulus of elasticity	4,100
Shearing	770

1. By careful air-seasoning to a moisture content as low as 15 per cent the strength of small clear specimens may be increased approximately 35 per cent.

2. Douglas fir varies greatly in quality, the different strength functions ranging in value 50 per cent above and below the averages quoted.

3. The analyses of the results to determine the relations existing between physical characteristics and mechanical properties of the wood show—

(a) That so-called red and yellow fir have practically the same strength; the yellow fir, however, contains fewer defects and is much more uniform in rate of growth.

(b) The mechanical strength varies directly with dry weight; that is, the heavier the wood the greater is its mechanical strength. The average oven-dry weight of Douglas fir is 28.8 pounds per cubic foot; the average weight of the green material is, approximately, 38.4 pounds per cubic foot; and the average weight of thoroughly air-seasoned material is, approximately, 33.1 pounds per cubic foot.

(c) The greatest strength of Douglas fir is most frequently associated with the rate of growth between 12 and 16 rings per radial inch.

(d) Knots and cross grains are the most significant factors in grading Douglas fir in structural sizes. The size and position of knots and the condition of the wood around them should be considered in judging their effect on the mechanical properties of the wood. The presence of knots appreciably decreases the strength of green Douglas fir in compression parallel to grain; the decrease is 22 per cent with knots greater than 1½ inches in diameter; 14 per cent with knots less than 1½ inches and greater than one-half inch, and 6 per cent in knots one-half inch in diameter or less. The decrease in compression strength at the elastic limit is 22 per cent, 13 per cent and 5 per cent, respectively. (See Table 6.) In beams the presence of knots affects most the modulus of rupture; the fibre stress at the elastic limit and the modulus of elasticity apparently

are more dependent upon the quality of the wood, and are much less influenced by such defects.

4. The tendency of specifications for Douglas fir in structural sizes is toward too great severity. The efforts to secure high-grade material generally result in throwing out much material of high structural merit. The specifications adopted by the American Society for Testing Materials and the American Railway Engineering and Maintenance of Way Association in a slightly modified form appear to be the most effective yet devised. In framing specifications, in addition to the points already brought out, the following general conclusions are of interest:

(a) Sound knots 1 inch or less in diameter which do not cause a marked disturbance in the grain should not be regarded as defects in structural timber.

(b) Sound knots larger than one inch in diameter should not be regarded as defects when they occur on the vertical faces and at a distance from the edge equal to at least one-fourth the height of the piece.

(c) Knots and cross grains which interrupt the continuity of the grain within 2 inches of the edge should not be allowed except in the lowest grade.

(d) Diagonal grain, due to sawing, that has a slant greater than 1 inch in 45 should not be allowed in the higher grades.

5. Douglas fir dimension stock seasons rapidly on the Pacific Coast between April and October; in three months the loss of weight in 8 in. by 16 in. by 16 ft. pieces is approximately 40 pounds out of a possible 60 pounds. During the subsequent rainy season timbers cease to lose weight, but during the second summer they reach a thoroughly air-dry condition.

Douglas fir is manufactured into almost every form known to the sawmill operator, and much round or hewed timber is used which never passes through a sawmill. A list of such forms and uses would represent many industries and would include piling and poles; mine timbers, railway ties, and bridge and trestle timbers; timbers for car construction; practically all kinds of lumber for houses, material for the furniture maker and boat builder; special products for cooperage, tanks, paving blocks, boxes, and pulpwood; fuel and a long line of miscellaneous commodities including wood for distillation.

Poles.

Railroad and telegraph companies use a limited number of Douglas fir poles in regions where this timber is cut. Usually the poles are logged from forest land where clean cutting is practiced, but occasionally second-growth stands are logged for poles alone. The young tree's long, tapering trunk gives it an admirable form for this use, but it can not compete with the abundant and more durable western red cedar, and to that fact is due the limited use of Douglas fir poles in regions where the cedar may be had. Its use for poles is restricted chiefly to county telephone and telegraph lines and to lines for carrying block signal wires, in regions where the cedar is more difficult to obtain. As the supply of cedar poles diminishes, and a satisfactory butt preservative treatment is developed for Douglas fir, it may be substituted for cedar. Large and attractive sawed poles of fir are in use on many electric car lines in cities where utility and handsome appearance are combined. Some of the street car lines in the vicinity of Washington, D. C., are equipped with Douglas fir poles.

Railway Ties.

Ties of Douglas fir are both sawed and hewed, though three-fourths are sawed. Much of the inferior timber in logging operations is worked into ties. Those which are sawed are made both from second growth and from mature trees. About two-thirds of the ties supplied by the forests of the western part of the United States are of Douglas fir, the remaining one-third consisting chiefly of western yellow pine, lodgepole pine, redwood, and western hemlock. Practically all the large sawmills in Washington and Oregon cut fir ties to order, and some small mills cut little or nothing else. It is customary to saw ties from a large portion of low-grade material obtained in the usual milling operations. Douglas fir generally yields about 25 per cent of high-grade lumber and the remaining 75 per cent must be worked into lower grade lumber, dimension products, timbers, and ties. Though the season in which the trees are cut probably influences the durability of the wood, no consideration is given to this element by the tie makers. A set of standard specifications which shows the requirements of Douglas fir ties follows:

Specifications for Sawed Ties.

Ties must be sawed out of red or yellow fir, and must be 7 inches thick, 9 inches wide, and 8 feet long. They must be sawed out of sound, straight, live timber, and must be free from bark, splits, shakes, sheathing and rough structural purposes, or, when shipped, is sold in the Plains States east of the Rocky Mountains and adjacent regions. The distribution of dimension material does not differ greatly from that of common lumber, except that a considerable quantity is exported to China, Japan, the Philippine Islands, and elsewhere. The large size timbers, however, go all over the world. The Orient depends largely upon them for heavy construction, as does the entire western part of the United States. Much of the massive timbering required by the Panama Canal is of this wood, and large shipments go regularly to Australian and Japanese ports, where they are resawed into various building forms. Europe affords a market, as do the Atlantic Coast States, for many cargoes of Douglas fir timbers that compete successfully with the yellow pines of the South. Douglas fir lumber is very widely distributed in all the countries of the Orient, in most European countries, South Africa, South America, and the South Sea Islands. Large amounts of it are sold in the central and eastern parts of the United States through retail yards.

Conduits.

The manufacture of conduits and water pipes is near akin to cooperage. Staves are largely used in the construction of conduits, and high-grade Douglas fir supplies great quantities. Such staves are made from flat-grained lumber, with the wood as nearly of uniform growth as may be had. They are made in such shape as to give the finished conduit a cylindrical

form, and its different parts are so closely fitted as to make it waterproof. When the pipe is 24 inches or less in diameter it is constructed from staves of special pattern, with grooved edges. Such pipes are built up at the factory, and are wound from end to end with mild steel wire, after which the exterior is covered with an asphalt-and-tar mixture for preservative purposes. The thickness of the staves and the pitch of the wire reenforcement varies according to the pressure under which the pipe is to be used. Conduits larger than 24 inches are set together at the place where they are to be used. Such pipes are always continuous, the staves being so placed as to break the joints. In large conduits the staves are usually 6 inches wide, with beveled edges, and are curved to conform to the diameter of the pipe. When the staves have been set in place, the pipe is drawn tight with steel bands and bolts, and all the joints are closed. Conduits thus constructed form important parts in the water systems of many western towns and cities, and are widely used for manufacturing plants, irrigation works, hydraulic mining, dredge work, oil pipes, wire conduits, for steam-pipe casing, and for various other purposes. Douglas fir pipes of this kind are used not only in the Pacific Coast States, but also in the Eastern and Middle States, in British Columbia, and in Alaska.

TELEGRAPH EXTENSION IN CHINA.

The Chinese telegraph administration, in view of the close working arrangements with the eastern extension, Australasia & China Telegraph Co. (Ltd.), British, and the Great Northern Telegraph Co. (Ltd.), Danish, on April 10 concluded an agreement with the two last-named companies whereby it is to receive an advance of £500,000 ($2,433,250) on the foreign traffic dues of the next 18 years; that is, the two companies are to have as security a lien on the balances payable by them on the Chinese telegraphs under the joint-purse agreement of July 11, 1896. This agreement and, in fact, all other existing agreements and concessions between the administration and the companies were extended to December 31, 1930, according to agreements signed by them August 4, 1900, and October 27, 1900. (See Hertslet's China Treaties, vol. 2, document Nos. 182 and 198.) Half-yearly adjustments of the principal are to be made, and the advance is to be made at par and carry interest at 5 per cent, which the rates at present cover.

It is stipulated that the money is to be utilized only for the development of telegraphs and telephones, and that the telegraphic charges on the land lines in China should be restricted to 10 cents Mexican (4 1-3 cents American currency) per word for all points within a Province and 14 cents (6 cents American) per word between all points within any two adjoining Provinces.

Any improvements and extension in telegraphic communications and in installing systems of telephones, as those contemplated by this loan, should create a demand and thus offer a promising market for appliances of all varieties along the above-mentioned lines.

TRANSMISSION SYSTEM OF THE GREAT WESTERN POWER COMPANY.[1]

BY J. P. JOLLYMAN.

The Great Western Power Company operates a long-distance, extra high-tension transmission system which extends from its hydroelectric plant at Big Bend, 16 miles north of Oroville, Cal., to Oakland, Cal. The nominal line voltage is 100,000, at 60 cycles. The length of the main line is 153.6 miles. A branch line 1.1 miles long taps the main line 136.5 miles from Big Bend. Both the main and branch lines are double circuit. Both are supported on steel towers.

1. The high tension sides of all the transformers are delta connected. There is no connection to ground, except through the electrolytic lightning arresters.

2. One ground wire, supported on the apex of the towers, is used. This is grounded at every tower.

3. The standard span is 750 feet; 3/0, seven-strand copper cable is used on the main line, No. 6 copper on the branch. Each circuit is completely transposed about every 10 miles. The arrangement of the conductors is shown in Fig. 1.

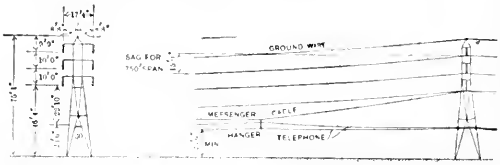


Fig. 1.

The longest span with regular towers and cable is 1998 feet. The longest span is 2740 feet. This is across the San Joaquin River near Antioch. Special towers are used. The conductors clear high water 125 feet. The six conductors are in a horizontal plane, 15 feet apart.

4. We have never yet had any lightning whatever .

5. The measured value of the charging current is very nearly the same as the value determined by using the ordinary formula for charging current based on the capacity of two parallel conductors. The distance between the conductors is taken as the average distance of 13.33 feet.

VALUES OF CHARGING CURRENT.

Volts at Big Bend	Computed Current	Observed Current	Kv-a.
70,000	35.7	36.0	4360
80,000	40.8	41.5	5750
90,000	46	47	7330

6. Line insulators used. General Electric strain type, Locke strain type, Thomas strain and suspension types. Only three or four insulators have broken down during the past year. In no case have we any reason to believe that the insulators may not have been damaged mechanically before it failed electrically. We consider that the suspension insulator is a success.

We have had no trouble with swinging of conductors wth suspenson insulators.

7. General Electric type T and type K-10 oil switches are both used. We have had no difficulty in

[1] Paper presented at the 28th Annual Convention of the American Institute of Electrical Engineers, Chicago, Ill., June 26-30, 1911.

opening load, short circuit or charging current. The indications are that these switches could be safely used on a considerably larger system than we now operate.

8. We have all kinds of load connected to our system, including synchronous motors. No attempt is made to neutralize the charging current by reducing the field on any synchronous load. Under ordinary conditions the power factor at the generating station is nearly unity.

For the convenience, speed and safety of operation, each generating unit should have a capacity of at least equal to the charging current of one line. In our case this means units of about 10,000 kw. We have at present four 10,000 kw. generators at Big Bend, each with a 10,000 kw., three-phase transformer. The station is planned to ultimately contain eight 10,000 kw. units.

9. Transformer Terminals. Oil-filled terminals were supplied. It has been found difficult to maintain them free from the possibility of leakage. They have been refilled with compounds designed to reduce the chance of leakage.

Oil Switch Terminals. We have used compound filled terminals. Experience has shown that compounds for use in high-tension terminals must be very carefully tested in practical operation before their suitability can be decided upon.

Outlets. The outlets from our buidings are primarily composed of plate glass windows five feet square, through the center of which the conductor passes. Various arrangements of extra insulation around the conductor have been tried. Our experience seems to show that the best arrangements of plate glass windows is to use a bare conductor of large diameter and leave as large an opening around the conductor as climatic conditions permit. The window should be so protected that rain may not run over the surface of the glass.

10. We are using electrolytic lightning arresters at each end of the main line. Having had no lightning we have had no experience with them as lightning arresters. We have operated one circuit without lightning arresters at either end for some time. Our experience has shown that they can not absorb [illegible] energy without being damaged and therefore their critical voltage must be higher than any dynamic [illegible] that may ever occur upon the system.

11. We have had no sleet, nor any trouble from wind since the line was finished.

12. There is no appreciable corona effect [illegible] main line. Probably no very great increase in [illegible] would produce corona on the branch line No. [illegible] wire. No part of the line is over 2000 feet [illegible] above sea level.

13. The telephone line is strung on the [illegible]. In regular spans it is supported by three [illegible] which are carried by a grounded messenger [illegible]. Drainage coils consisting of the 2200-volt winding of a two kw. transformer with the center point grounded are used at both ends and in the center of the [illegible]. These reduce the voltage to ground of the telephone line to a very low value, probably less than 100 volts. This obviates the necessity for especially high insulation and reduces the noise due to unequal leak[illegible]

Highly insulated repeating coils are used where connections are made to telephones at which it is impossible to secure adequate insulation to ground of the person using the instrument. The telephone line is transposed at every tower where the towers are evenly spaced. Where the tower spacing is uneven the distance between transpositions is made as even as possible. The service obtained from this line is very satisfactory and is not more than momentarily interrupted by disturbances on the power line.

14. The only difficulty in maintaining satisfactory voltage regulation is at times when changes in load amounting to a large percentage of the total occur suddenly.

15. Steel towers whose general dimensions are given in Fig. 1 are used. Foundations suitable to the character of the ground must be used. Piles are used in very soft ground, cut off below the ground water level. The tower footing is attached to the top of the pile. All the tower footings are set in concrete. There have been no signs of corrosion in two years.

16. The system has been operated at 100,000 volts since November 1, 1909.

Our experience indicates that the following points should receive special attention when planning an extra high tension, long distance transmission system:

Generator capacity to handle the charging current.

Provision for the proper control of the system under all possible emergency conditions.

If delta operation is contemplated, insulation should be provided that will safety withstand the full delta voltage. The insulation should be of a character especially adapted to withstand transient voltage strains considerably in excess of the delta voltage.

THE BRIQUETTING OF LIGNITE.

The results of the investigations into the briquetting of lignite have just been published by the Bureau of Mines in Bulletin No. 14. Charles L. Wright, who conducted the tests and who is author of the bulletin, declares that enough testing has been done to indicate that some American lignites equal German lignites in fuel value and can probably be made into briquets on a commercial scale without the use of binding materials.

Three samples of lignites, one from Texas, one from North Dakota, and one from California, were made into satisfactory briquets without the addition of a binder. It was proved that some lignites after having slacked by exposure can be made into briquets without the use of binding material, notwithstanding a general opinion that this could not be done. Cohesion and weathering tests demonstrated that good briquets endure handling and resist weathering much better than the lignite from which they are made.

The tests described apparently show that the cost of briquetting run-of-mine lignites with a German plant, which was used, would be from $1.35 to $1.75 per ton, according to the location of the plant. The cost per ton of briquets, loaded on cars, from a briquet plant at the mine would be, in Texas, $2.51; in North Dakota, $3.53; and in California, $5.24.

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CONTENTS

P. A. Y. E. Cars

In the enterprising little city of Missoula, Montana, there have been in successful operation for over a year the new and up-to-date pay-as-you-enter cars. For the traffic of this city of 15,000, under this new and admirable system, but one operator is necessary on each car. The new equipment has proven thoroughly practicable and in its operation has been found rapid, convenient and void of confusion. The remarkably few accidents met with in this system should command the careful consideration of other municipal corporations entertaining a change from the old style of operation.

Western Enterprise

The spirit of enterprise and aggressiveness has ever been synonomous with the spirit of the West. Today we see the budding young hamlet which tomorrow will make the thriving city. The phenomenal growth of Los Angeles, the San Francisco bay cities, Portland, Seattle, Tacoma and Spokane came as no surprise to the careful observer. Their citizens were imbued with the brave optimistic boosting spirit known only on the western slope of the Rockies. The careful observer of today can predict with almost scientific accuracy the coming cities of tomorrow.

It is true that first of all a community in order to have a future must have a legitimate excuse for existence such as climate, natural resources, future natural commercial opportunities, richness of soil of surrounding country either predominating in some one feature or possessing many in combination. But this alone is not sufficient. Cities in the past have failed and ever remained stunted in their growth when every natural blessing seemed to favor them. It is easy to find the cause. A lack of self-sacrifice on the part of its citizens will do more to kill a community than any other single feature of its civic life.

The Pacific Coast States fairly vibrate with the young life and fostering spirit of its cities. From a financial point of view, one of two things usually aid in transforming a town into a city. It must either have manufacturies within sufficient for self support or the immediate surrounding country must be under such a high state of development as to need a substantial distributing point. Like anything else in life the good things only come by earnest unceasing effort. Manufacturies come to a place through individual effort. Material inducements offered to bona fide prospective manufacturies have done more to locate industries in young cities than any one thing.

Medford, Oregon, can be cited as one instance where public spirited enterprise is shown by one of its public service corporations. H. C. Stoddard, manager of the Rogue River Electric Company offers in the name of his company free electric power for one year to any manufacturing concern establishing a plant there which does not compete with any concern already established. This example is worthy of imitation in our other young progressive cities in the west. It means self-sacrifice today, but tomorrow the reward will be certain!

Watershed Data

We present in this issue a careful compilation of data showing the relation between precipitation and elevation in the Owens River country. In our issue of July 1st we printed an abstract of a paper by Professor D. W. Mead of Wisconsin University on the "Flow of Streams and the Factors That Modify It," with special reference to Wisconsin conditions.

A systematic study of stream flow will eventually solve many of the problems now live issues before the American people, such as the value of forests for increasing or equalizing stream flow and the application of storage not only for the prevention of floods but for the promotion of the uniform flow required in navigation and essential for power and watershed purposes.

It is with considerable pride that we note from time to time the careful collecting of data concerning our great natural watersheds, both by government and private enterprise. As in the swinging of the magnetic pole in its pendulum vibrations, we find repetitions of declination every series of years, so there seems to be in all natural phenomena a periodic return of conditions from time to time. Since the forces are so variable which bring about our climatic [illegible] that it is almost impossible to foretell with exactness for any given season the amount of precipitation in any one locality, we are fortunate if we can determine it within reasonable limits.

By careful comparison of data collected from time to time it is surprising with what degree of exactness the limit can be determined. So it is as years go by and carefully compiled data continues to heap up from the study of our great watersheds, we shall more and more be able to arrive at exact definite conclusions as to the laws governing precipitation, run-off and evaporation which will prove of invaluable service to mankind. Thus we shall be enabled to arrive at definite factors of safety to use in conduit design as well as in the design of diversion works and spillways. [illegible] most of the great watersheds in some of our [illegible] States, such as Montana and Wyoming, lie within national forests, it is gratifying to note that the forestry officials are gathering, with considerable exactness, data on the monthly and even daily flow of smaller streams. These have in a measure been necessarily overlooked by the U. S. Geological Survey in their series of water compilations. Such data have already proved of inestimable value to [illegible] in one of the great fruit valleys of Montana [illegible] have given definite ideas as to proper design for storage reservoirs and ideas as to the factors of safety to be allowed in designing spillways and diversion works to take care of unusual flow and prevent disaster.

Workman's Accident Compensation

On October first of this year the workman's compensation act passed by the last Legislature of the State of Washington, will go into effect in that commonwealth. The details of this law appeared in our issue of July first.

From every point of view the question of workman's compensation in event of accident while employed in any one of the industries is, perhaps, one of the most vital now before the employer and his men. The daily press is filled with accounts of the mammoth lawsuits brought by the employed against the employer for injuries received while at work. The suit eventually goes to trial. We read of the impression made upon the jury by the bandaged appearance of the injured when he is brought into court or of their tear-stained eyes when they look upon the pretty, helpless widow and her children. A large award is made, and yet upon inquiry we find that the injured, when paid, is as financially helpless as before.

Upon investigation we are informed that the heavy legal expenses in fighting the case have left but the widow's mite, although several thousand dollars should be at her disposal. The question then eventually resolves itself to this: if it is just and proper that compensation should be paid by the employer to his employed in event of injuries sustained while at work, a proper and speedy remedy should be at hand.

Similar to all other forms of risk, either insurance with private companies organized for such purposes should be required by law and maintained jointly by the employed and his employer in a just and fair distribution of the burden, or the government should enact proper regulations and make just awards. The funds for this purpose should be acquired by monthly or annual premiums paid in by the employed and the employer in each craft in amounts shown to be necessary according to statistics compiled from long periods of time.

The question of dealing out justice in the case of accident incurred at work in the industries and the amount of responsibility therefor which should justly rest upon the employed or his employer is one of the most delicate to be determined in any given case. Unquestionably many accidents occur that are absolutely and wholly to be laid against improper and unsafe equipment, but on the other hand it is impossible to make any workshop in the great industries absolutely "fool proof." Then again many accidents occur which are absolutely unforseen and cannot be avoided, no matter what wisdom in design the employer may show in planning the equipment or the care exercised by the workman in going about his daily tasks. But such acts of Providence should be provided for somewhere and somehow in this uncertain world.

It should [illegible] the many just cases in which awards have been made, and yet, when the inventory is taken of what is left the widow and her children, find the lawyer and expenses incident to his work have absorbed nearly the whole, while the employer has also spent an equal amount in attempting to defend the case. From the employer's point of view, too, the thousands of dollars annually spent in successfully defending suits would, if this enormous expense be done away with by an examining commission, go a long way towards establishing a sinking fund to take care of genuine cases of liability.

In New York and many of the other great cities of the world, have been established Museums of Safety. These have done much towards the prevention of accidents. For those that are unavoidable may the near future evolve some equitable, speedy and sure method by which the sufferer or his widow may find relief.

PERSONALS.

M. R. Cahill of the Diehl Manufacturing Company is spending his vacation on the Pacific Coast.

Rudolph W. Van Norden, consulting engineer, San Francisco, is investigating an irrigation project near Stockton, Cal.

Ralph D. Mershon, a prominent consulting engineer of New York, was a visitor in San Francisco during the past week.

F. J. Lepreaux of the Edison Manufacturing Company, manufacturers of the Edison-Lalande battery, is at Los Angeles.

Arnold Pfau, hydraulic engineer with the Allis-Chalmers Company's factory, arrived at their San Francisco office last Saturday.

J. W. White, of the Fort Wayne sales department, has just returned to his San Francisco office after a flying trip to Los Angeles.

Cas Gilson, formerly salesman with the Pacific States Electric Company, has opened the Oak Electric Supply Company at Oakland, Cal.

H. R. Noack, manager of Pierson, Roeding & Co., after recent extensive trips to the East and Middle West, is now on his homeward journey.

Isaac W. Anderson, of Tacoma, Wash., who is interested in electric railway lines in the district tributary to Walla Walla, arrived at San Francisco last week.

Frank W. Hall, manager of the Philadelphia office of the Sprague Electric Works, has been appointed manager of hoist sales and after July 15, 1911, will be at the New York office.

E. R. Hill, of the firm of Gibbs & Hill, the New York electrical engineers who have had charge of the Pennsylvania Railroad tunnel work, was at San Francisco last week.

A. C. Sprout, electrical engineer, will spend most of the summer in Siskiyou County on electrical construction work for the Siskiyou Light and Power Company. About $30,000 worth of construction material has just been purchased for use on the system.

R. D. Holabird, president of the Holabird-Reynolds Company, has returned to his San Francisco store after an Eastern trip of two months. He spent ten days at Seattle where he has just doubled the space occupied by the branch on First avenue South, in that city.

H. H. Noble, president of the Northern California Power Company, has just returned to his San Francisco office after an inspection of the construction work in progress at the Coleman power station and elsewhere. He was accompanied on the trip by Edward Whaley, the auditor and purchasing agent of the corporation.

Alfred H. Coates, president of the Colonial Electrical Agency Company, of San Francisco, Cal., expects to leave early in July on his annual eastern trip. He will spend some time in Warren, Ohio, at the headquarters of the Colonial Electric Company and the Economy Electric Company, both of which concerns are represented on the Pacific Coast by Mr. Coates' company.

Bion J. Arnold, consulting electrical engineer, and Past President of the American Institute of Electrical Engineers, has of late been engaged in professional work in Los Angeles. Mr. Arnold has been employed by many of the large cities, including Chicago and Los Angeles, upon investigations of their electric traction problems. In fact, the Board of Supervisors of San Francisco have been considering the advisability of securing his advice with a view toward bettering the local street railway service.

James A. Clifford, manager of the Baltimore office of the Sprague Electric Works, has been appointed manager of the Philadelphia office and took charge there on July 1, 1911. The Baltimore office will be continued as in the past under Mr. Clifford's direction, but as subsidiary to the Philadelphia office and with Henry S. Patterson in charge.

C. L. Cory, consulting engineer, accompanied by Mrs. Cory, left San Francisco last week via boat for the Pacific Northwest. Professor Cory has been retained by Mr. Huntington of the Washington Water Power Company to make an independent valuation of the company's holdings. Upon completing his work at Spokane he will take a pleasure and business trip East, returning to Berkeley in about six weeks

V. H. Greisser, electrical engineer of the Washington Water Power Company, of Spokane, Wash., has just returned from a five weeks' trip in the East. The prime purpose of his visit was to select the switching apparatus for the new 90,000 h.p. hydroelectric plant which this company is building at Long Lake, thirty miles from Spokane. This plant will include all features necessary to make it one of the most complete installations from an operating standpoint, that exist in the country. While in the East Mr. Greisser visited power plants and transmission systems at Chicago, Niagara and in the Carolinas.

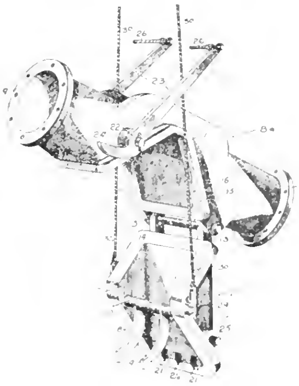
James H. Wise, hydraulic engineer with F. G. Baum & Co., has been appointed assistant general manager of the Pacific Gas and Electric Company of San Francisco. He assumed his new duties on July 1st, and will oversee the construction and extension of a number of new steam and hydroelectric plants to be added to the company's system. Mr. Wise entered the employ of the Pacific Gas and Electric Company a year after his graduation in 1903 with honors from the mining department of the University of California, the interim having been spent in teaching mathematics at the California School of Mechanical Arts. Serving first as instrument man and later in charge of field work, he was soon made assistant to Frank G. Baum. When the latter resigned as hydraulic and civil engineer, Mr. Wise succeeded to the position, which he resigned early in 1910, to join forces with Frank G. Baum & Co., being retained as consulting engineer with the Pacific Gas and Electric Company.

TRADE NOTES.

Agutter-Griswold Company of Seattle, Wash., announce that they have given up the construction end of their business and will devote their attention to the manufacture of switches, switchboards, panelboards, steel cabinets, mitering panels, etc. The completion on June 1st of their new factory, supplied throughout with the best of machinery and equipment, puts them in position to better handle their largely increased manufacturing business and makes it possible at this time to make this change.

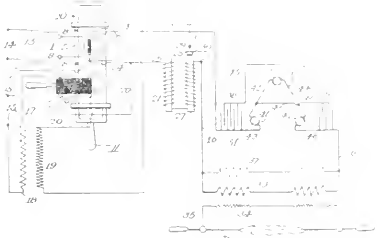
PATENTS

996,237. Hydraulic Dredging Apparatus. Fred H. Gridley, Long Beach, Cal., assignor of forty-five one-hundredths to North American Dredging Co. of Nevada, Los Angeles, Cal. A stone arrester for hydraulic dredges comprising in combination, a housing adapted to be connected into and form part



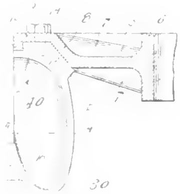
of the suction pipe of said dredge, said housing having a port therein, a grid adjacent to said port, a closure for said port, said closure normally held to place by fluid pressure external to said pipe but adapted to move from said normal position when the excess of external pressure is removed.

996,280. High-Tension Discharge Apparatus. Edgar J. Ro... Los Angeles, Cal. In a high-tension discharge apparatus, a charging circuit comprising means for connection of supply current, a self-induction means, and a circuit controller, electro-magnetic means for operating said circuit controller comprising a coil, an armature controlled thereby and operating the circuit controller, and a spring acting on the armature



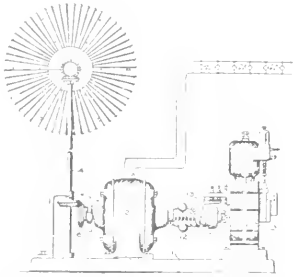
opposition to the coil, the time period of the electro-magnetic means being shorter than the time period of the charging circuit, so that at each operation the electro-magnetic operating means restores the normal condition before the discharge of the self-induction coil ceases, and a discharge circuit including a condenser and high tension transformer connected to said circuit controller.

996,525. Turbine Water-Wheel. Sherrod W. Reece, Portland, Ore. In a turbine water wheel, a supporting plate or spider having an inclined flange portion from the upper edge of which a horizontal flange extends in an outward direction, said flange being provided adjacent to its outer edge with a downwardly extending rim co-operating with the horizontal flange and with the inclined flange portion to form an annular recess, in combination with bucket members having angular reinforcements forming head pieces fitting in said recess and



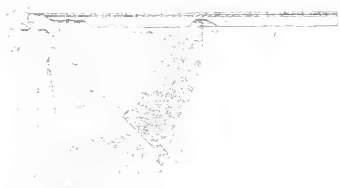
provided adjacent to their outer edges with notches for the reception of the rim and with threaded sockets, and cap screws engaging said sockets through the flange of the spider to draw the reinforced portions of the buckets into the annular recess where said reinforced portions will be securely seated.

996,334. Driving Dynamos from Variable and Non-Variable Sources of Power. Caryl D. Haskins, Schenectady, N. Y., assignor to General Electric Company. The combination with a generator, of means for maintaining a fairly constant potential on said generator comprising a fluctuating



source of power, a steady source of power, and means for coupling said generator to the latter source when the former falls below a critical speed and for automatically uncoupling the steady source when the fluctuating source exceeds the critical speed.

996,591 Combined Bevel, Protractor, and Rule. Joseph La Follette, Portland, Ore. An instrument of the class described comprising a scale bearing plate having notches adjacent to two of its corners, a rule having a longitudinal groove into which

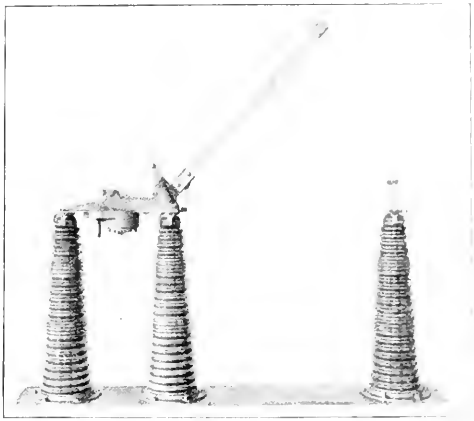


one edge of the plate fits, a shoulder in one end of the groove for engaging one of the notches on the plate, a pivoted locking lever on the rule having means for engaging in the other notch of the plate to hold the rule detachably in place.

INDUSTRIAL

PNEUMATICALLY OPERATED DISCONNECTING SWITCHES.

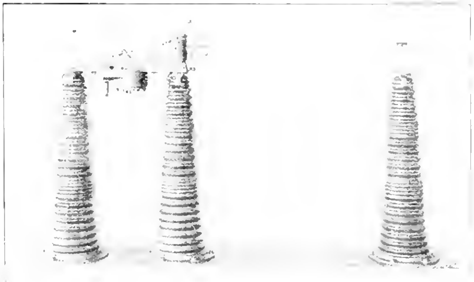
Bus isolating or disconnecting switches are usually opened or closed by means of a wooden rod, having at one end a hook to engage with the hole in the switch blade. Ordinarily this is quite satisfactory.



Pneumatically Operated 110,000 Volt Switch (Open)

In many cases, however, to simplify the wiring layout, to save in length of large cables, for convenience, or for safety, it is advisable to locate the disconnecting switches in a position where they cannot be easily reached by the station operator. It is in such connection that pneumatically operated disconnecting switches find useful application.

The switches of this type, made by the General Electric Company, are clearly shown in the accompanying illustrations. They can be located at any height and can be controlled by an air control valve or pull button switch located at the switchboard or other convenient point.



Pneumatically Operated 110,000 Volt Switch (Closed)

These switches are simple and substantial in construction, being similar to the hand operated switches and introduce no complications in wiring. They are mounted on post type insulators fastened to steel bases, the insulators varying in size according to the voltage.

The switches are made up in single pole, single throw form only, but can be opened and closed singly or any number of poles can be operated in unison. Also, one or more sets can be operated simultaneously by a single air control valve or pull button switch. This gives great flexibility of operation.

Pneumatically operated disconnecting switches are especially adapted for use in stations employing air operated oil switches, but can, of course, be used in any case where an air supply is available.

When a pull button switch is used to operate the disconnecting switch the valves in the air connections to the diaphragm are operated electrically—usually from the lighting or exciter circuit. These switches are made in voltages from 35,000 to 110,000 and for currents of from 100 to 300 amperes.

LIGHTING A FACTORY LOCATION.

Among all the reports on lighting installations that have appeared in the past months, there are comparatively few that deal with the question of lighting the rougher locations such as machine shops, mills, factories and the like, due to the fact, no doubt, that very little work has been done along this line or that those conducting the work have little time to report on it.

It is the object of this article to describe the manner in which a very dark machine shop was lighted, by a very simple but effective method and one that has given entire satisfaction to all concerned.

The location in question is a typical inside factory one, being an aisle 40 feet wide situated between two other aisles of a slightly greater width, and separated from them only by the columns that carry the roof. Four hundred feet of this aisle is used for general machine work, mostly lathe work. The height of ceiling is 12 feet. The ceiling is formed by the floor above, of wood (2 by 8 in.) and is divided into bays 40 by 18 ft. by the supporting girders. A crane runs the entire length of the aisle with a clearance of only 13 in. above the hoist.

The natural lighting comes from the aisles on each side, one having a row of windows occupying the entire outside wall, the other making use of sky lights and a row of windows just under the roof at a height of about 50 feet from the floor. The light from the first source was mostly cut off by a row of high machines directly in front of the windows and by the intervening columns, crane girders and the like. From the other side, the windows being so high in comparison with the width of the room, only a narrow strip of floor was directly lighted and this only imperfectly on account of the machines located just along the edge of the aisle. It was necessary to use artificial light at all times as under the best conditions of a bright day the natural light was very dim, presenting a worse condition than if there had been absolute darkness, the mixture of daylight necessitating a higher artificial intensity than would otherwise have been necessary.

Formerly, clusters of carbon lamps scattered here and there, formed the general lighting scheme, each machine being furnished with one or more extension lamps which were moved from place to place as the operator required. Not only was the light insufficient but the constant transfer of lamps with the consequent breakage and damage to the cord made the maintenance cost so high and reduced the efficiency of the workmen, both in quality and quantity, to such an extent that some change was made necessary. It was impossible to keep good men on account of the inconvenience and unpleasantness of the location.

The small clearance over the crane together with the low ceiling excluded all types of lamps except the incandescent. Carbon lamps in sufficient numbers would have required an excessive current consumption so that tungsten units were

selected as being the most applicable. At the time there was some doubt as to the advisability of using tungsten lamps as the floor above was used for machining heavy castings and the constant dropping of these, it was feared, would cause a large breakage of lamps, they being of the old fuse type.

In order to determine the exact effect that this would have on the life of the lamps, two bays were each equipped with eight 100 watt, clear tungsten lamps, with Intensive glass reflectors, mounted directly on the ceiling with one inch of free cord between the rosette and the socket. The lamps being in two rows, of four lamps each per day, thus making the spacing distance 8 by 10 ft. with a power consumption of 1.25 watts per square foot of floor space. The switching was arranged so that four lamps could be operated in a group, thus permitting small areas to be lighted without waste. After several weeks operation the breakage was found to be only slight. With a replacement by the Westinghouse Wire-Type lamp the breakage has disappeared regardless of the vibration due to cranes and to the dropping of heavy weights on the floor above.

Illuminated Factory Interior.

The illumination was uniform and of sufficient intensity for the class of work done there, and the place was transformed from a gloomy into a cheerful location. The spirit of the men improved as was shown by the quality of the work turned out. The floor was kept cleaner and the whole appearance of the place improved. In fact so satisfactory was the result that the entire 25 bays were similarly equipped. All extension lamps have been removed except where it is necessary to see into deep work or under machines. For this purpose plug boxes have been placed at convenient places and the extension lines are used only when necessary, with the result that the general lighting scheme is never interfered with and the room is free from the mass of cord that generaly characterizes like locations.

This system has been in service for well over a year and careful records have shown that the cost is reasonable and that the saving in quality of work and the ability to keep good men has more than repaid the original expense.

The accompanying photograph, taken at night without any light except from the ordinary source, shows the location and gives some idea of the satisfactory character of the illumination. All parts of the room are sufficiently lighted to permit of work being done with equal ease at any point. Tests showed that the average intensity on the horizontal plane averaged 2.5 foot-candles, with a minimum of 1.6 foot-candles at the extreme edge of the room.

GENERAL ELECTRIC COMPANY'S NEW CATALOGUES.

In Bulletin No. 4818, issued by the General Electric Company, are described flange couplings and flexible couplings.

The General Electric Company's Bulletin No. 4829 illustrates and describes electric locomotives built for both standard and narrow gauge, in various styles.

The General Electric Company has recently issued Bulletin No. 4846, which contains such information as will enable the prospective customer to select intelligently the switchboard panels best suited to his needs.

Bulletin No. 4852, just issued by the General Electric Company, contains a description of a standard 50-ton locomotive and its equipment, and a statement of features of construction.

The General Electric Company has developed a line of commutating pole generators in which commutating trouble is eliminated. These generators are built for slow and moderate speeds, range in capacity from 20 to 150 kw. and are wound for 125, 250 and 575 volts. They may be equipped with sliding base or with belt tightener, as desired. They are described in Bulletin No. 4832, which contains also a table giving dimensions.

Catalogue K from the Ohio Brass Company, of Mansfield, Ohio, is devoted to Ohio valves and steam specialties, special attention being given to their water gauge and their pressure regulating valve, a device which automatically delivers steam or air at any desired uniform pressure lower than that supplied to the valve. In connection with this is a valuable chart for determining the proper size of regulating valve for a given service.

The General Electric Company has just issued a publication describing another of its flow meters, which, in this instance, is designed for measuring the flow of steam. Two forms of the steam flow meters are manufactured; one for recording and the other for merely indicating the flow. This meter resembles somewhat the air and water meters manufactured by this company, and is fully illustrated and described in this publication, which is No. 4836.

Bulletin No. 4851, just issued by the General Electric Company, is an attractive publication containing data relative to the use of electricity in the service of steam roads. The publication comprises 48 pages which illustrate and describe both station and road equipment of the New York Central & Hudson River Railroad; the Detroit Tunnel of the Michigan Central Road; the Cascade Tunnel of the Great Northern Railway; the equipment of the Baltimore & Ohio Railway; the West Jersey & Seashore, the West Shore Railroad, etc.

The General Electric Company's line of belt driven alternating current generators, known as Form B generators, are described in Bulletin No. 4847, recently issued by that company. These generators are built in capacities ranging from 50 to 200 kw., and are adapted for three-phase or two-phase winding without change except in the armature coils and terminal blocks, the exciters and all accessories being the same for both. Designs have been made for 240, 480, 600, 1150 and 2300 volts.

The General Electric Company has recently issued Bulletin No. 4848, describing its new combination ammeter and voltmeter. This instrument is enclosed in a dust-proof and moisture-proof aluminum case, and is designed to withstand the constant vibration and exposure incident to service on electric vehicles. The publication contains dimension and connection diagrams, and illustrations in actual size of the scales.

NEWS NOTES

FINANCIAL.

ELMA, WASH.—The council has decided to vote municipal bonds for $10,000 for the construction of a water system.

PORTLAND, ORE.—The Clatskanie Electric Light & Power Company has increased its capital stock from $[illegible]5,000 to $75,000.

INDEPENDENCE, ORE.—A $25,000 bond issue for a water system has been decided upon. Work on the new water system is to begin at once.

ALAMEDA, CAL.—The City Council held a special session last week to consider the items for the proposed bond issue. The council decided to include $125,000 for the electric light plant, including $75,000 for general betterments $25,000 for a new building and $15,000 for new wire, other smaller items taking up the additional $10,000. The plant is now carrying a 40 per cent overload.

BERKELEY, CAL.—On the strength of a report presented by City Expert C. L. Cory on the income of the electric light company, the Berkeley City Council failed to reduce the rate from 9 to 7c per kw. hour. John A. Britton, representing the company, stated if the rate was cut to 8c that the profits of the corporation in Berkeley would be reduced $24,000 a year, while the 7c rate would mean a difference of $60,000 a year. Cory's estimate placed the value of the plant at $[illegible]76,886.82 and gave the net revenue of the plant at $[illegible]37, allowing for depreciation at 7.98 per cent annually. The report was compiled by comparing the expenditure and revenue of the corporation for the past three years. Mr. Britton asserted that the company was compelled to charge the 9c rate in order to get a revenue on the investment, that it was exceedingly low when compared with that of other cities.

INCORPORATIONS.

OAKESDALE, WASH.—The Oakesdale Home Telephone Company, capital $10,000, has been incorporated by C. G. Mead and A. G. Woodward.

SAN FRANCISCO, CAL.—The Mokelumne River Power Company has been incorporated with a capital stock of $3,000,000, by L. Brown, A. H. Elliott, A. M. Sherman, M. E. Logan and G. C. Elliott.

HOOD RIVER, ORE.—Articles of incorporation of the Hydroelectric Company of Hood River have been recorded in the county clerk's office. The incorporators are W. Evans, J. Watt and H. J. Jackson. Capital stock $250,000.

RIVERSIDE, CAL.—The Vernon Park Water Company has been incorporated with a capital stock of $75,000 with $500 subscribed. The directors are A. H. Bailey, R. C. Harding, H. V. Wall, R. J. Brien and C. E. Lewis, all of Los Angeles.

TRANSMISSION.

LACROSSE, WASH.—Representatives of the Washington Water Power Company are here with a view of extending their lighting and power systems to this city from Colfax.

PORT ORCHARD, WASH.—The Bremerton & Charleston Light & Fuel Company has petitioned the county commissioners for a franchise to furnish electric current for lighting and other purposes on certain streets and roads.

PROSSER, WASH.—The Pacific Power & Light Company has started work on the expenditure of $15,000 for improving its local power plant. Three new transformers of 66,000 volts and one 600 kilowatt generator will be installed.

WALLA WALLA, WASH.—R. E. Downie & Co., Seattle, has been awarded the contract for furnishing a quantity of 50-ft. poles for the Pacific Power & Light Company's power line under construction from this place to Dayton, Wash.

KLAMATH FALLS, ORE.—Judge William Colvig of Medford, representing the Rogue River Electric Power Company, has arrived in Klamath Falls and has submitted to the city council a proposition to furnish this city with electric power.

VALLEJO, CAL.—The government has asked for bids to cover the cost of pipe and boiler construction for a new power house, which will represent an expenditure of more than $100,000. The figures are to be opened in Washington on July 8th.

EUREKA, CAL.—Since the Western States Gas and Electric Company has taken over the holdings of the Fortuna and Ferndale lighting companies, improvements are to be made throughout the valley. The substation at Loleta will be moved further up the river.

PASCO, WASH.—Vice-President Grenier of the Pacific Power & Light Company will shortly award the contract for constructing the first unit of the switching station for that company. Plans for the first unit which will cost $85,000 are on file at the Portland and local office.

WOODLAND, WASH.—Preliminary surveys are being made to establish the water line, etc., at Tum Tum canyon, 30 miles above this place, for a company which will erect a power dam 150 ft. high to generate 3000 h.p. Work will start this summer and power and light will be distributed to adjoining towns.

ILLUMINATION.

SANTA ANA, CAL.—The Board of Supervisors will receive sealed bids up to July 6 for furnishing electric lights on certain streets in Garden Grove Lighting District.

NEWPORT, WASH.—The Northern Idaho & Montesano Power Company has been granted a franchise for the construction of an electric lighting system for the village of Priest River, Wash.

TRANSPORTATION.

WOODLAND, CAL.—The City Trustees have granted the Vallejo & Northern Railroad a franchise on Main street from the eastern to the western limits.

BISHOP, CAL.—Grading began last week on the Owens Valley Electric Railway connecting Bishop with the Southern Pacific at Laws, with proposed extensions to neighboring places.

CHICO, CAL.—The Board of Trustees has passed an ordinance granting the Northern Electric Railway Company, a franchise to operate a street railway over certain streets in Chico.

SAN BERNARDINO, CAL.—W. G. Kerckhoff has entered into negotiations with the local Chamber of Commerce for the construction of an electric line from San Bernardino to Upland. He asked that steps be taken to secure right of way for the line.

EUGENE, ORE.—Deeds for the right of way for several miles of the electric railway to be built between Eugene and Corvallis by the Portland, Eugene & Eastern Railway, have been filed for record with the county clerk. Construction will begin before December 1 next.

OAKLAND, CAL.—Work has begun by the Key R[illegible] on its line to Richmond, which branches off its local lines [illegible] 54th and Adeline streets. The track is practically [illegible] pleted and poles to carry the trolley wires are being se[illegible] The work should be completed within a few months and [illegible] line in operation before the end of the present year.

OAKLAND, CAL.—The first electric train of the S[illegible] Pacific Company ran into Oakland last week on a tr[illegible] In Alameda the first run of an electric train was made [illegible] the north side Lincoln avenue line to High street. Bo[illegible] perimental trips were successful, and according to the rail[illegible] officials it will be a matter of only a few weeks till [illegible] lar electric service is established on the new [illegible] which swings down to the east end of the island.

OAKLAND, CAL.—Pursuant to plans formed [illegible] by the management of the Oakland and Antioch R[illegible] Company and the financial backers of the concern [illegible] York and Boston, a corps of engineers is now surv[illegible] new line for the road between Walnut Creek and O[illegible] which will include a new inter-county tunnel. The [illegible] will be two miles in length, according to one [illegible] and longer according to another. Three [illegible] kind are being laid out.

OAKLAND, CAL.—Plans for a [illegible] central [illegible] the Oakland Traction and Key Route and Oakland [illegible] tioch lines in the business center of Oakland [illegible] worked out by the engineers and expert traction [illegible] United Properties Company. [illegible] and passenger distributing station [illegible] in a year and it will occupy the building [illegible] Oakland Produce Exchange, between [illegible] ster and Harrison streets. [illegible] will take steps at once to have [illegible] amendment be necessary, to [illegible] the main lines of the Oakland Tr[illegible] erally understood and the direc[illegible] ber of Commerce are considering [illegible] porting the movement.

SAN FRANCISCO, CAL.—There ha[illegible] Supervisors an application for a [illegible] railway to extend from the ferry [illegible] street to Golden Gate Park. The [illegible] backing of one of the greatest En[illegible] The real applicant for the franchise [illegible] on Monday through a local agen[illegible] tion Company, which contro[illegible] way systems of England and A[illegible] to be willing to put $15,000,000 [illegible] tion at once and, if the franch[illegible] work without delay. It is [illegible] have prepared preliminary [illegible] the subway can be com[illegible] Thomas King Ewer, now in th[illegible] tive of the British Electr[illegible]

TELEPHONE AND TELEGRAPH.

CORNING, CAL.—The Bo[illegible] ordinance granting the right [illegible] telephone system throughout [illegible]

CENTRAL POINT, ORE.—The [illegible] Company for $12,000 for the ext[illegible] has been accepted by the counc[illegible]

NAPA, CAL.—W. M. Lyons, h[illegible] Board of Supervisors for a franch[illegible] to operate telephone lines al[illegible] county. Sealed bids will be receiv[illegible] of Supervisors up to July 11, 191[illegible] chise.

FULLERTON, CAL.—The Board of Supervisors has granted the application of the Standard Oil Company for permission to lay [illegible] and telephone wires across the county roads at their [illegible] way.

PETALUMA, CAL.—W. D. Thomas is negotiating with [illegible] Maggetti, Messrs. Berri, Camboni and many other farmers in the district near Marshall, for the installation of a rural telephone line from Marshall to Petaluma.

WELLS, NEV.—The request of C. G. Winters asking for a permit to set poles and build a telephone line from the State line of Nevada and Idaho, commencing at Rattlesnake springs on Wilkin's island, has been granted.

WATERWORKS.

LIVINGSTON, CAL.—Constable J. A. Watson has been granted permission by the Board of Supervisors to lay pipes under the streets of Livingston for the purpose of maintaining a water system.

ORANGE, CAL.—The Board of Supervisors has passed an ordinance granting a franchise to Santos Moraga to construct a water system for supplying Richfield for domestic and other purposes for fifty years.

HOQUIAM, WASH.—Portland capitalists are considering a plan to bring water from Lake Quinault to this city, furnishing both Hoquiam and Aberdeen. J. D. Moughmer, former city engineer, is one of the promoters.

SAN FRANCISCO, CAL.—The Board of Public Works has been authorized to go ahead with the repair and enlargement of the water supply system at the Relief Home, the cost of which was estimated at $16,000.

OAKLAND, CAL.—The Peoples Water Company announces that the corporation will commence the laying of 2700 feet of [illegible] mains in the Hopkins street district in the [illegible] for the purpose of increasing the water supply of the district.

[illegible], CAL.—At the next meeting of the Alder[illegible] attorney will present a prepared ordinance call[illegible] for a special election at which the people will be asked to [illegible] an indebtedness of $[illegible] for the purpose of construct[illegible] an entire new water system.

BERKELEY, CAL.—The City Council has set the mini[illegible] rate at $1[illegible] and made the hydrant rate of $3, [illegible] rate of 30 [illegible] protest on [illegible] of the People's Water Company [illegible] and Attorne[illegible] minimum [illegible] of $1.00 [illegible] would operate under.

SAN FRANCISCO, CAL.—[illegible] water famine in the [illegible] of water com[illegible] held a conference [illegible] the Mill [illegible] five of the Spring [illegible] Bowden of the Pe[illegible] in San Mateo and [illegible] of the chair[illegible] with the board [illegible] Development Board [illegible] made that a [illegible] supply for San [illegible] deemed advisable [illegible] companies oper[illegible] the oppor[illegible] if Spring Val[illegible] San Francisco that the company to be [illegible] with [illegible] Valley for a fixed and [illegible] for the [illegible] and future.

INDEX TO ADVERTISEMENTS

JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXVII SAN FRANCISCO, JULY 15, 1911 NUMBER 3

JORDAN STEAM STATION

The Utah Light & Railway Co. supplies practically all of the electric service for Salt Lake City, Utah, and during its growth has absorbed a large proportion of the output of the hydroelectric power generating and transmission companies which utilize water powers in the mountain region surrounding Salt Lake City. The increase of the business and the somewhat restricted possibilities of the available water powers have led the management of this company to provide a steam driven power station, primarily for the purpose of acting as a relay to the various hydroelectric transmission systems, and in order to form a nucleus of such further steam generating equipment as the future may require. The presence of coal measures in the Wasatch Mountains within 40 or 50 miles of Salt Lake City by rail led to an investigation to determine the best site for such a plant, and at this stage of the proceedings Westinghouse, Church, Kerr & Co. of New York were retained to act as engineers and report on the situation. In July, 1909, after considering the advisability of producer gas as well as steam, and the location of the plant at the coal mine, as alternatives, they reported in favor of a steam power station to be located (preferably on the Jordan River) adjacent to Salt Lake City. In the spring of 1910 this report was acted on, and the engineers were authorized to act also as constructors, and to proceed with the design and construction of the new power station.

Power House of Utah Light & Railway Company

Among the conditions governing the design of this station were the following:

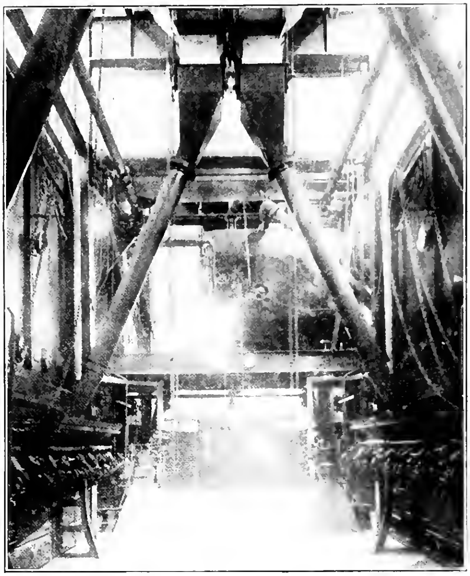
(a) Operation not continuous at first, but as a relay to the system; (b) an ample supply of condensing water, unsuitable, however, for boiler feed; (c) feed water to be purchased at a relatively low cost; (d) coal to be brought from mines already developed in Wyoming carrying about 11,700 B.t.u. per pound; (e) power station site being on property owned by the company and having railroad connection.

The fact that the station is intended to be a relay and not continuously operated, implies a very low load factor which called for the exercise of economy in first cost of construction. Accordingly, the building as well as the contained equipment was to be laid out as to reduce the volume per unit of generating capacity to a very low figure. The cubic contents of the building (which includes ample switchboard room for all the generating equipment it can contain) is 56 cubic feet per kilowatt of maximum continuous output.

This station is designed on the so-called "unit system," a "unit" comprising a self-sufficient combination of boilers, generating units, condensers, and enclosed building, so arranged that it can be uniformly and economically duplicated, and when so duplicated, economically operated either alone or in parallel with

the other sections. As shown in the plan, the boiler room, which is completely filled with six 600 h.p. boilers, is of the same length as the turbine room with its single 10,000 k.v.a. turbo-generator, condenser and auxiliaries. It is evident that future needs for greater capacity of this station can be economically met by adding to it one or more units of equipment and enclosing building of the same size as this first one.

The power station building is of brick, with concrete slab floors and roof. The boiler room includes an overload coal bunker. This portion of the structure is of skeleton steel construction carrying the greater part of the weight on columns. The turbine room requires no steel framing other than that needed for the roof trusses, floor beams and crane rails. While no money was spent to secure architectural effect, the design is well proportioned and dignified in character.



Boiler Room

The foundation of this station rests upon a pile concrete mattress composed of Oregon fir piles 36 ft. long, spaced 2½ to 3 ft. between centers, overlaid with a practically uniform thickness of 3 ft. of concrete. The condenser intake and overflow flumes, where within the building line, are formed in the concrete foundation. The main flumes extend from the river bank just outside of and parallel to the building wall, being so placed that they can readily be extended to accommodate future additions to the station, which will be served as in the present case by branches extending from the main flumes into the power station foundations.

Steam is generated in six 600 h.p. Stirling boilers fitted with the improved Roney stoker operated by natural draft which is supplied by a single stack. The steam pressure is 200 lbs. with 125 degrees superheat. The arrangement of flues and stack was designed to fit in with the general unit system which will involve the building of an additional stack for every six boilers added to the plant. The boilers next the turbine room are provided with a cross flue running just under the coal bunker, for connecting them with the stack. By means of a system of skylights placed just below the level of the coal bunker, the firing alley between boilers is provided with far better daylight illumination than usual.

The load conditions at this plant did not warrant the installation of economizers. The stack is of radial brick, 11½ ft. in diameter and 225 ft. high. Commercial relationship with the management of the mines rendered it unnecessary to make provision for storing coal on a large scale, thus simplifying the problem of transferring the coal from the railroad cars to the stoker hoppers. The cars dump into a track hopper from which coal is carried up by an inclined bucket elevator to the top of the boiler house at one end, where it discharges onto a horizontal belt conveyor by which it is distributed through the bunker over the boilers. The ashes are dumped from the ash pits into side dump cars which run on an industrial railroad in the boiler room basement and are elevated by a platform lift to the ground level, where they are run out to dump their contents as filling for adjacent land.

The main turbo-generating unit is of 10,000 k.v.a. maximum continuous capacity, with a temperature rise of not to exceed 50 degrees C. The machine is of the Westinghouse-Parsons semi-double flow type of 3600 r.p.m., and generates three-phase, 60 cycle current at a potential of 4400 volts.

The condensing apparatus is of the mixing type, the LeBlanc condenser being furnished by the Westinghouse Machine Company. Although it has usually been the practice, where feed water has to be purchased, to use a surface condenser, the LeBlanc type is usually able to show a vacuum of ½ in. to 1 in. better than the surface type, with similar water temperatures except where an unusual expenditure is incurred in maintaining the surface condenser. The greater efficiency due to a greater vacuum, combined with the reduced cost of maintenance, more than offsets the increased cost of feed water that has usually accompanied the older forms of mixing condensers.

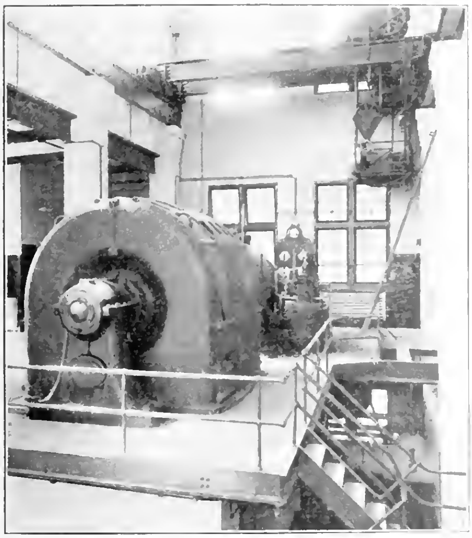
As is the case with other main features of the power house equipment, the piping is of distinctly modern design and construction. Pipe flanges for high pressure steam are welded on, and cast steel fittings and valve bodies are used. The valve seats, discs and spindles are of Monel metal. Particular attention is also given to providing for the expansion and contraction inevitable with high pressure steam and superheat temperatures. The Holly Gravity Return System is used in returning condensation in the main steam connections back to the boilers.

The generators are fitted with the usual ventilating ducts. The exciters are of the Westinghouse turbine driven type of 100 kw. capacity. The boiler feed pumps are steam driven, of the compound duplex pressure pattern. The air and circulating pumps on the LeBlanc condenser are driven by a small steam turbine.

The switchboard apparatus is contained in a cellular structure of the type now so common in high ten-

sion power stations, being in this instance built of solid concrete. The ring type of bus has been adopted as offering the greatest flexibility in switching combinations of generators and feeders, with the least number of switches installed. The oil switches are General Electric type H-3, electrically operated from a bench board of the usual type.

Progress in the construction of this station has been remarkably rapid. Active construction began about August 19, 1910, upon the arrival of the first carload of piles. By the middle of October the piles



Interior View Showing Generator

were all in and the concrete wall enclosing the basement was well along towards completion. By November 10th the building walls were nearly finished and the stack well under way. By the middle of December the exterior of the building was completed, the windows were in and the stack was finished. Steam was raised in the boilers on January 6, 1911, the turbine was turned over for the first time on February 15, and the station was reported ready to permanently carry commercial load on March 22, 1911. The entire work of design and construction was executed by Westinghouse, Church, Kerr & Company, under the direction of the Utah Light & Railway Company officials, Mr. O. A. Honnold, electrical engineer being in charge of the work for them.

EROSION OF SLOPES OF CULEBRA CUT AT PANAMA.

Arrangements have been made to sow various kinds of grass seeds on the slopes of Culebra Cut, with a view to reducing erosion. The seed has arrived and will be planted under the direction of Mr. H. Pittier, a botanist from the Smithsonian Institution.

This method of plant growth on large ..ts has proved eminently practical in various American engineering enterprises in the prevention of erosion.

CHARACTERISTICS OF TRANSMISSION LINES

In a paper presented at the Twenty-eighth Annual Convention of the American Institute of Electrical Engineers, held at Chicago, June 26-30, 1911, Harold Pender and H. F. Thomson presented an ingenious series of practical solutions of the mechanical and electrical characteristics of transmission lines.

We publish herewith the charts submitted in this paper and will take illustrations of such a simple nature in the way of their application, we hope they may become of much practical service with minimum effort employed.

Before proceeding further it will be of value to note the assumption made in arriving at the equations from which the charts were plotted. The treatment naturally falls under two headings: A—Mechanical Characteristics; and B—Electric Characteristics.

In arriving at the equations for the mechanical characteristics of transmission lines the discussion was limited to the consideration of the characteristics of a perfectly flexible wire suspended from two fixed points of support. Actual wire spans closely approximate this condition, particularly when the successive spans are all of the same length, whether the supporting insulators be of the pin or of the suspension type. In the case of successive spans of unequal length the change in tension in the various spans, due to the variation of temperature and the mechanical load on the wire, will not be the same in each span, and consequently such changes will produce a resultant force on the insulator, causing thereby a slight deflection of the top of the tower; or a deflection of the insulator only, if the latter is of the suspension type. This motion of the points of support will tend to equalize the tensions in the various spans.

In the design of a wire span two problems must be solved: 1. At what tension (or sag) must the wire be strung in order that the tension in the span may not exceed a definite limit under the worst conditions of temperature and of mechanical loading (due to ice and wind): and 2. What will be the maximum vertical sag of the wire for a given variation in loading and temperature? The factors which enter into these two problems are the following:

1. The length of the span.
2. The material of the wire.
3. The size of the wire.
4. The co-efficient of linear expansion of the wire. For copper this co-efficient is 9.6×10^{-6} and for aluminum 12.8×10^{-6}, the temperature in each case being expressed in degrees Fahrenheit.
5. The modulus of elasticity of the wire. The modulus of elasticity for copper or aluminum is not strictly a constant, but may be assumed as such as a first approximation. For copper this modulus varies from 12×10^6 to 16×10^6, depending upon the quality of the wire and upon whether the wire is stranded or solid. The former figure is generally used for stranded copper wires. For aluminum wire, which is always stranded when used for transmission lines, the modulus is equal to 9×10^6. The modulus M is equal to the increase of tension (ΔT) in pounds per square inch required to produce an elongation ($\Delta\lambda$) of a given length of wire (λ) divided by the ratio of the elongation to the original length, i. e.:

$$M = \Delta T \div \frac{\Delta\lambda}{\lambda} = \lambda\frac{\Delta T}{\Delta\lambda}$$

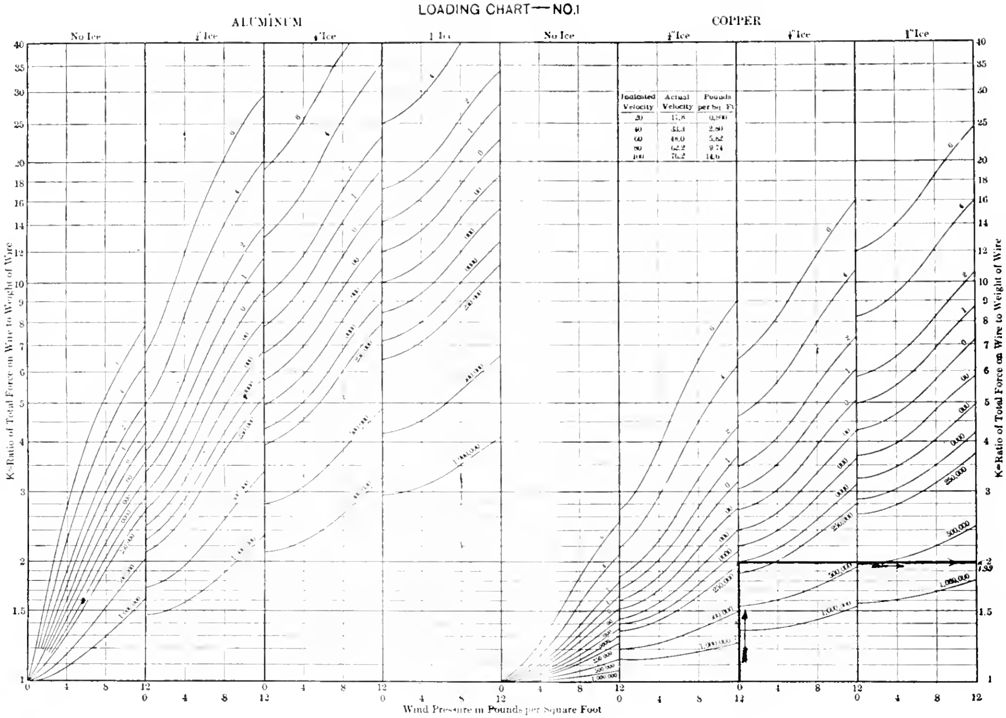
6. The maximum tension in pounds per square inch to which the wire should be subjected. This maximum allowable tension is usually taken at one-half the ultimate tensile strength of the wire, about 30,000 lb. per sq. in. for copper and 13,000 lb. per sq. in. for aluminum.

7. The maximum external load to which the wire may be subjected due to the collection of sleet on the wire and the pressure of the wind against it. This, of course, will depend upon climatic conditions, but even for a given section of the country, there is considerable difference of opinion as to what should be assumed as a reasonable external load. The Joint Committee on Overhead Line Construction has recently recommended that the maximum loading for high tension crossings be taken as that due to an ice coating 0.5 in. thick all around the wire plus a wind pressure of 8 lb. per sq. ft. of the projected area of this ice cylinder. To meet this requirement on a long span, especially with aluminum wire, would require a relatively large sag, from 30 to 100 ft., depending on the length of span and size of wire. This would require a prohibitive height of tower, at least for level country work. For cross country spans it would, therefore, seem advisable to assume a less heavy loading, particularly as an ice coating of 0.5 in. and a wind velocity of 60 miles per hr. (corresponding approximately to 8 lb. wind pressure) will seldom, if ever, exist simultaneously.

8. The minimum temperature at which the maximum external load occurs. Here again there is considerable difference of opinion, even for given climatic conditions. The Joint Committee on Overhead Line Construction recommends the assumption of a minimum temperature of −20° Fahrenheit for lines situated in the northern part of this country. For cross country spans the assumption of a higher temperature would seem more reasonable, in view of the fact that sleet seldom exists on a wire when the temperature is much below freezing.

9. The temperature at which the wire is to be strung. As an average stringing temperature 70° Fahrenheit is a reasonable assumption.

LOADING CHART—NO.1

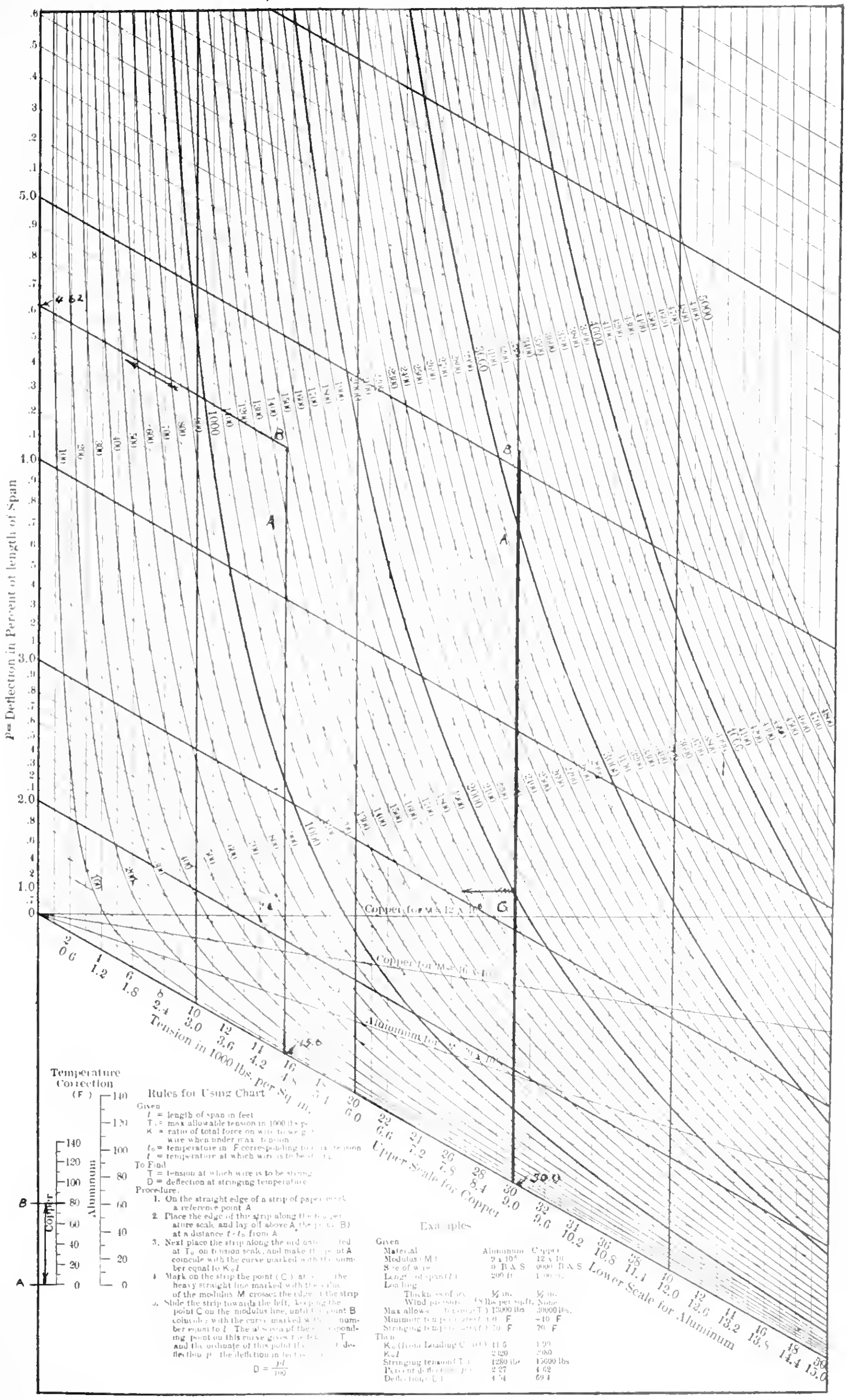


10. The maximum temperature to which the wire may be subjected. For lines located in the northern part of this country a maximum temperature of 120° Fahrenheit is reasonable. It should be noted that the temperature of a wire exposed to the sun is considerably higher than the temperature of the surrounding air.

The interrelation of these various quantities in the case of a wire suspended from two fixed points of support were considered in detail.

The total force on a span of wire under any condition of mechanical loading consists in general of three components: 1, its own weight; 2, the weight of the ice coating; and 3, the force acting on it due to wind pressure. It is usual to assume that the wind pressure is horizontal, although it may have a considerable vertical component, particularly if the span is parallel to the

TENSION AND DEFLECTION CHART — NO. 2



base of a steep hill. The other two components of the resultant force on the wire are vertical.

For convenience we will let K equal the ratio of total force on the wire to weight of wire under these same conditions. The values of this ratio K for the various sizes of wire between 1,000,000 circular mils and No. 6 B. & S. gauge for both copper and aluminum, for no ice and for ice thicknesses of ¼, ½ and ¾ in., and for wind pressures from 0 to 12 lb. per sq. ft., are plotted on Chart No. 1. On this chart is also given a short table showing the relation between indicated wind velocity and pressure per sq. ft. The latter is deduced from the formula given by H. W. Buck in the Transactions of the International Electric Congress, 1904; this formula is that the wind pressure in pounds per sq. ft. of projected area of a round cylinder of diameter d_1 produced by an actual wind velocity of V miles per hour is $0.00021\ V^2\ d_1$.

In the discussion the wind pressure is assumed perpendicular to the vertical plane through the two points of support and the pressure per foot of wire in the direction of the wind will be assumed constant at all points irrespective of the angle between the wire and the direction of the wind. This assumption is not strictly realized since the wire near the points of support will make an angle of less than 90° with the direction of the wind, and therefore to obtain an exact solution the wind pressure should be resolved into its two components, one acting in the direction of, and the other perpendicular to, the wind. Since the angle between the wire and the direction of the wind is in general very nearly 90°, the assumption that the wind pressure actually exerted on the wire is equal to the pressure which would be exerted were the wire in a vertical plane normal to the wind will not introduce an appreciable error, in comparison with the variations in the wind pressure which will occur due to the actual variation in wind velocity at different parts of the span.

The general case of the points of support at different elevations is also considered, and the wire is assumed to lie in a plane through the two points of support parallel to the direction of the resultant force. This assumption is not strictly realized when there exists a combination of wind pressure with the two points of support at different elevations, but is strictly true in all cases when the points of support are at the same elevation, and in the former case gives a solution as nearly correct as can be obtained without an elaborate analysis.

When a given amount of electric power is transmitted over a transmission line to a substation or other receiver, a certain amount of power is lost in the line. There is in general a difference in the voltage between wires at the two ends of the line, and the power factor at the sending and receiving ends will be different. The power loss, voltage loss, and change in power factor in general depend upon the following factors:

1. The amount of power delivered.
2. The voltage at which the power is delivered.
3. The power factor at the receiving end.
4. The frequency of the system.
5. The kind of line—three-phase or single-phase.
6. The length of the line.
7. The size of the wires.
8. The material of the wires.
9. The temperature of the wires.
10. The arrangement of the wires on the poles; particularly their distance apart.

The interrelation of these various factors will be considered in detail.

For wires of the size ordinarily used in practice and for any frequency up to 60 cycles, the resistance of a solid wire per unit length depends solely upon the material of the wire and its cross section. A stranded cable has a slightly greater resistance than a solid wire, due to the spiralling of the individual wires which made up the cable. In the table on Chart No. 3 are given the resistance and weight per mile of both copper and aluminum for the various sizes between a No. 16 and 1,000,000 circular mils. This table is calculated for a temperature of 20° Centigrade (=68° Fahrenheit), assuming a temperature co-efficient of 0.42 per cent per degree of Centigrade; the conductivity of copper is taken as 98 per cent and the conductivity of aluminum as 62 per cent of Matthiessen's Standard; and the resistance and the weight of the stranded wires are taken one per cent greater than for solid wire of the same cross section.

The reactance of a wire in ohms is equal to $2\pi f L \times 10^{-3}$, where f is the frequency and L the self-induction in millihenries. The self-induction of a round solid wire of radius a inches when the return wire is parallel to it and at a distance D inches from it (center to center) is

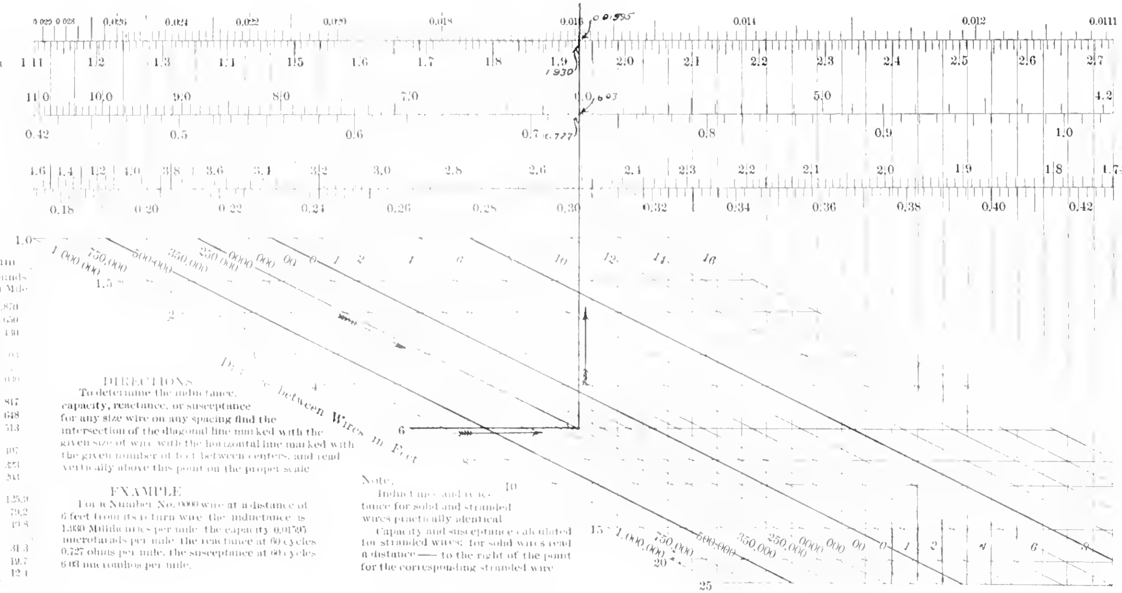
$$L = 0.7411 \log_{10} \frac{D}{a} + 0.0805 \text{ millihenries per mile.}$$

This formula applies also when the return circuit consists of two wires each of which is at a distance D from the wire in question; that is, the above formula gives the inductance per mile of each wire whether the system is single-phase or three-phase, provided in the latter case the wires are arranged symmetrically (i. e., form the three edges of an equilateral prism). The inductance of a stranded wire is practically equal to that of a solid wire of the same cross section of conducting material; for a given number on the B. & S. gauge or for a given area in circular mils the inductance is therefore independent of whether the wire is solid or stranded.

The value of the inductance per mile of wire for various sizes of wire and for various spacings is given on Chart No. 3. This particular form of chart arises from the fact that the inductance depends only upon the ratio $\frac{D}{a}$; consequently all combinations of sizes and spacings for which this ratio is constant give the same value of the inductance. The reactance for both 25 and 60 cycles is also given on Chart No. 3.

The capacity susceptance of a wire in ohms is equal to $2\pi f C \times 10^{-6}$, where f is the frequency and C the capacity in microfarads of the wire to neutral; the susceptance of a wire is the ratio of the charging current to the volts to neutral. The capacity to neutral of a round wire of radius a inches when the return wire

LINE CONSTANTS PER MILE OF ONE WIRE—NO. 3



Size C.M. and B. & S.	Diameter Inches	Copper Ohms per Mile	Copper Pounds per Mile	Aluminum Ohms per Mile	Aluminum Pounds per Mile
1,000,000	1.152	0.0566	16,440	0.0894	4,870
750,000	0.994	0.0751	12,400	0.1193	3,650
500,000	0.813	0.1130	8,070	0.1788	2,430
350,000	0.679	0.1616	5,650	[illegible]	[illegible]
250,000	0.590	[illegible]	[illegible]	[illegible]	[illegible]
0000	0.530	[illegible]	[illegible]	[illegible]	[illegible]
000	0.470	0.337	2,710	0.533	817
00	0.420	0.425	2,150	0.672	648
0	0.375	0.536	1,703	0.848	513
1	0.330	0.676	1,351	1.068	407
2	0.291	0.852	1,071	1.347	323
4	0.231	1.355	[illegible]	2.14	203
Solid 6	0.162	2.13	119.5	3.37	125.9
8	0.1285	3.38	263.9	5.35	79.2
10	0.1019	5.38	166.0	8.51	49.8
12	0.0818	8.55	104.4	13.53	31.3
14	0.0641	13.58	65.6	21.5	19.7
16	0.0508	21.6	41.3	34.2	12.4

DIRECTIONS

To determine the inductance, capacity, reactance, or susceptance for any size wire on any spacing find the intersection of the diagonal line marked with the given size of wire with the horizontal line marked with the given number of feet between centers, and read vertically above this point on the proper scale.

EXAMPLE

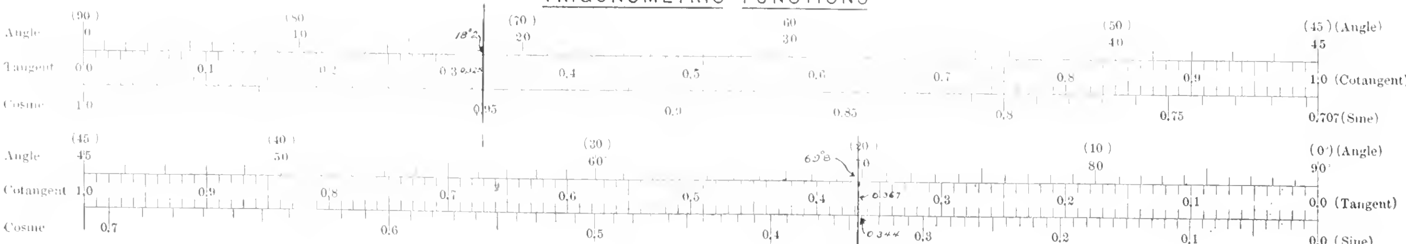
For a Number No. 0000 wire at a distance of 6 feet from its return wire the inductance is 1.930 Millihenries per mile, the capacity 0.01795 microfarads per mile, the reactance at 60 cycles 0.727 ohms per mile, the susceptance at 60 cycles 6.03 micromhos per mile.

Note.

Inductance and reactance for solid and stranded wires practically identical.

Capacity and susceptance calculated for stranded wires; for solid wires read a distance —— to the right of the point for the corresponding stranded wire.

TRIGONOMETRIC FUNCTIONS



For bracketed functions read bracketed angles. Example sin 60° = 0.866, cot 60° = 0.578

is parallel to it and at a distance D inches from it (center to center) is

$$C = \frac{0.03883}{\log_{10}\frac{D}{a}}$$

provided $\frac{D}{a}$ is greater than 12 and the distance from the wire to all other conductors is large compared with D. This formula applies also when the return conductor consists of two wires each of which is at a distance D from the wire in question. That is, the above formula gives the capacity per mile of each wire whether the system is single phase or three phase, provided the wires are at a great distance, compared with D, from all other conductors (i. e., overhead lines) and provided that in the case of a three-phase system the wires are arranged symmetrically (i. e., from the three edges of an equilateral prism). The capacity of a stranded wire is greater than that of a solid wire, since its radius is greater. The above formula is not strictly applicable to a stranded wire since the latter is not round, but as a first approximation it may be used.

In Chart No. 3 is given the capacity of the various sizes of wire on various spacings. In calculating the capacity scale the diameter of the wire in each case was taken 15 per cent greater than the diameter of a solid wire of the same cross section; the ratio of the diameter of a stranded wire to a solid wire is approximately 1.15. The proper correction to obtain the capacity of a solid wire is indicated on the chart. The chart also gives the capacity susceptance at 25 and 60 cycles.

The leakage current between wires under ordinary working conditions is negligible. The leakage need be taken into account only in the case the voltage is sufficiently high to produce the so-called "corona effect." This effect appears only when extra high voltages are used and the wires are comparatively small.

The equations plotted upon the charts are accurate in case the length of the line does not exceed 100 miles when the frequency is 60 cycles, or 200 miles when the frequency is 25 cycles.

Example.

Given a three-phase transmission line, 60 cycles, No. 0000 B. & S. wire, 6 ft. apart, 100 miles long, voltage at receiving end of line 60,000, current delivered 100 amperes, power factor of receiving circuit 0.95 lagging. The modulus of elasticity of copper used is 12×10^6, length of spans between towers 1500 ft., no wind encountered, thickness of ice ½ in., maximum allowable tension of wire 30,000 lb. per sq. in., minimum temperature —10° Fahrenheit, stringing temperature 70° Fahrenheit. Determine all the transmission characteristics of this system.

A. Determination of Mechanical Characteristics.

By referring to Chart No. 1 under column headed copper ½" ice, we find black line at foot of chart for 0 wind pressure. Looking vertically upward to the intersection of curve marked "0000," then passing horizontally to the right of chart, we read 1.99. This is the ratio of the total force upon the wire under these conditions to weight of wire. Since the span is 1500 ft. in length we next multiply by 1.99 and arrive at the total force upon the wire, which we find to be 2980 lb. Next we determine the range of temperatures our span will be subjected to, which in this case is seen to be 70+10, or 80° in all, and with this data at hand we proceed with five simple operations on Chart No. 2, as follows:

1. On the straight edge of a strip of paper mark a reference point A.

2. Place the edge of this strip along the temperature scale which is to be found in the lower left-hand corner of Chart No. 2 and lay off above A the point (B) at a distance $t-t_0$ from A. In our illustration $t-t_0$ is equal to 80° and copper is the material used, hence employ the copper temperature scale.

3. With A and B marked thus on the straight edge of paper, then place the strip along the ordinate erected at T_0 on the tension scale, and make the point A coincide with the curve marked with the number equal to K_0l. In other words, since we found K_0l to be 2980 lb. in our illustration and since T_0 is assumed at 30,000 lb. in our example, we place our strip upon the vertical line emanating from 30 on the copper scale at the lowest diagonal line on Chart No. 2, being careful to make our point A coincide as nearly as possible with the curve 2980 or very nearly upon curve 3000.

4. Mark on the strip the point (C) at which the heavy straight line marked with the value of the modulus M crosses the edge of the strip. In out illustration the modulus of elasticity was assumed to be $M=12\times10^6$.

5. Slide the strip toward the left, keeping the point C on the modulus line until the point B coincides with the curve marked with the number equal to l or the length of span, which is 1500 ft. in our illustration. The abscissa of the corresponding point on this curve gives the tension T and the ordinate of this point the per cent deflection p; the deflection in feet is then $D = \frac{pl}{100}$. We find that the operation thus described leads us vertically above point marked 15.6 or stringing tension of our wire is 15,600 lb., and following diagonal line to left we read 4.62 per cent deflection for (p). Thus the deflection of our span of wire of 1500 ft. is found to be 69.4 ft.

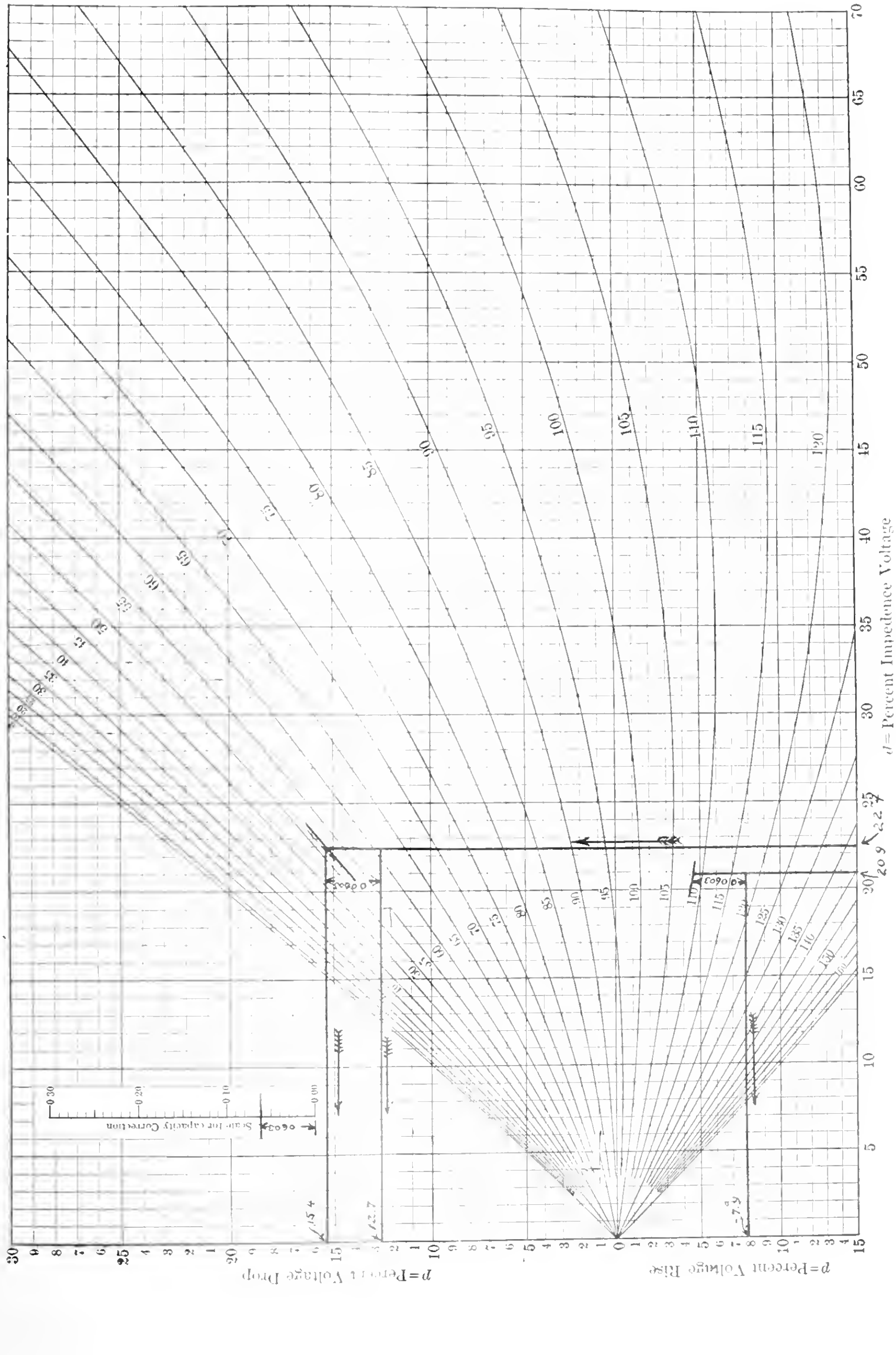
B. Electric Characteristics.

Having given to us the terminal voltage current, and power factor, and other data as listed in our example, we proceed with Chart No. 3 as follows:

Since our power factor is 0.95 lagging, and remembering that the power factor is the cosine of the angle of lag or lead, we consult first the lower scales headed Trigonometric Functions and opposite point on cosine scale numbered 0.95 we read 0.328 on the tangent scale and 18.°2 on the angle scale. Hence the tangent of the angle of lag is 0.328 and the angle itself is 18°2.

The resistance of No. 0000 copper wire per mile of transmission is easily taken from the table of resist-

CHART NO. 4.


d = Percent Impedence Voltage
p = Percent Voltage Drop
p = Percent Voltage Rise
Scale for capacity Correction

ances on Chart No. 3 and is found to be 0.267 ohms per mile.

To determine the inductance, capacity, reactance, or susceptance for any size wire on any spacing, find the intersection of the diagonal line marked with the given size of wire with the horizontal line marked with the given number of feet between centers, and read vertically above this point on the proper scale. Thus since our wire is No. 0000 at a distance of 6 feet from its return wire we easily find the inductance is 1.930 millihenries per mile; the capacity 0.01595 microfarads per mile; the reactance at 60 cycles 0.727 ohms per mile; the susceptance at 60 cycles 6.03 micromhs per mile, or 6.03×10^{-6} mhs. per mile. Since the equivalent impedance (Z) of receiver per mile of line $= \dfrac{E}{\sqrt{3}\, l\, I}$ for three-phase line, we have Z = 3.46 in our illustration. Since the tangent of the angle whose cosine represents the line-power factor is the reactance, divided by the resistance per mile of each wire, we have in our illustration 2.62 as the tangent of this angle, which represents an angle of 69.°8, the cosine of which is 0.344. Since the tangent in this case is greater than 1, it is well to reverse the process and divide resistance by reactance, obtaining 0.367. Looking at the cotangent scale of Trigonometric Functions plotted on Chart No. 3 we find similarly 69.°8 as our angle and 0.344 as its cosine.

Our problem now divides itself according as to whether we shall neglect capacity effect or take it into consideration.

Regulation, Power Loss and Power Factor.

Let l = length of each wire in miles.

E = volts between wires at receiving end.

I = amperes per wire delivered to receiver.

k = power-factor or receiver as a decimal fraction.

$\phi = \cos^{-1} k$ = power factor angle of receiver (positive for lagging current).

Z = equivalent impedance of receiver per mile of line.

$= \dfrac{E}{\sqrt{3}\, l\, I}$ for three-phase line, $= \dfrac{E}{2\, l\, I}$ for single-phase line.

r = resistance per mile of each wire in ohms (see Line Constant Chart).

x = reactance per mile of each wire in ohms (see Line Constant Chart).

$e = \tan^{-1}\dfrac{x}{r} = \cot^{-1}\dfrac{r}{x}$ (see scale for Trigonometric Functions).

b = capacity susceptance per mile of each wire in ohms (see Line Constant Chart).

To find q = power loss as a percentage of power delivered.

p = volts lost in line as a percentage of volts delivered.

k_0 = power-factor of sending end of line.

A. Capacity Neglected.

1. $q = \dfrac{100r}{z\,k} = \dfrac{100\times0.267}{3.46\times0.95} = 8.13\%$ in our illustration.

2. $d = \dfrac{100r}{Z\cos e} = \dfrac{100\times0.267}{3.46\times0.344} = 22.4\%$

and the difference between the line power-factor angle and the load power-factor angle is the difference between 69.°8 and 18.°2, or 51.°6. Finally p or volts lost in line as a percentage of volts delivered is found from Chart No. 4. It is the ordinate of the point which is on the curve marked with the number equal to the numerical value of the difference of the angles or 51.6 in this case, and which has the abscissa equal to 22.4, or d, as given above. By referring to the chart we find $p = 15.4\%$.

3. Hence the power-factor K_0 of the sending end of the line is found by simple substitution in the equation

$$k_0 = \frac{100+q}{100+p}\,k = \frac{100+8.13}{100+15.4}\times0.95 = 89.0\%.$$

B. Line Capacity Taken Into Account.

1. Calculate q and p as above, neglecting capacity. We have already found these values to be $q = 8.13\%$ and $p = 15.4\%$. Then true per cent power loss is

$q^1 = q - 100\,b\,r\,l^2\tan\phi$
$= 8.13 - (100\times6.03\times10^{-6}\times0.267\times(100)^2\times0.328)$
$= 8.13 - 0.53 = 7.60\%$.

2. To find the true per cent drop p^1 measure down from the point corresponding to p on the ordinate scale a distance equal to $b\,l^2$ measured on the "capacity" correction scale. $b\,l^2 = 6.03\times10^{-6}\times(100)^2 = 0.0603$. In performing this operation we find $p^1 = 12.7\%$, which is then the true per cent voltage drop.

3. To find the current at sending end of line calculate the quantity $d^1 = 100\,b\,z\,l^2$

$$= 100\times3.46\times0.0603 = 20.9\%.$$

Then find on the curve marked with the number equal to $90° + \phi$ or in our case 108.2, the point which has the abscissa d^1, and measure vertically downward from this point a distance equal to $b\,l^2$ on the "Capacity Correction Scale." In other words, measure down a distance equal to 0.0603 on this scale. The resultant ordinate p_i is the per cent excess of the current of the sending end I_0 over the receiver current and in our case is equal to -7.9%. Hence the sending current is

$$I_0 = \frac{100+p_i}{100}\,I$$

$$\text{or } I_0 = \frac{100-7.9}{100}\times100 = 92.1 \text{ amperes.}$$

4. The power-factor at the sending end is

$$K_0^1 = \frac{100(100+q^1)\,K}{(100+p_i)(100+p^1)} = \frac{100(100+7.60)\times0.95}{92.1\times113.6} = 97.7\%.$$

TRANSMISSION SYSTEM OF THE GREAT FALLS POWER COMPANY.[1]

BY M. HIBGEN.

The Great Falls Power Company is at present operating a total of 282 miles of transmission line at 100,000 volts. The principal transmission is from Great Falls to Butte, Montana, a distance of 130 miles. Over this distance two separate, single-circuit, tower lines are used, a single line being extended from Butte to Anaconda, a distance of 22 miles.

All transformers connected to the system are delta connected, this form of connection being very satisfactory in every way.

Above the transmission wires are located two ground wires consisting of 3/8-in. seven-wire, Siemens Martin steel strand, galvanized. These ground wires are clamped to the steel towers and are thus grounded at every tower through the tower legs. The tower legs extend six feet into the earth, and terminate in flat steel feet, which act as ground plates. No additional ground is provided.

The standard span for level country is 600 ft. In hilly country, however, there is no regularity in the length of the spans, and spans of from 1000 to 2000 ft. are common, no special construction being employed except to side guy the towers. The conductors are spaced 10 ft. 4 in., and all three conductors lie in a horizontal plane with no transpositions whatever. The conductor is No. 0 B. & S. gauge, six wire, hard drawn copper strand with hemp center. The normal clearance of wires from the earth is 29 ft.

The longest span in the line is 3034 ft., and occurs at the crossing of the Missouri River. In this span 3/8-in., Siemens Martin steel strand is substituted for the copper conductors, and a spacing of 20 ft. between wires is employed, two conductors only being supported by each tower. Standard towers and insulators were used, the insulators being doubled.

During the summer severe lightning storms are frequent in the vicinity of the line, and several of these have occurred since the line was put in commission at 100,000 volts but as yet no shut-downs have been occasioned by lightning and only mild discharges have taken place over the lightning arresters. It is believed that the overhead ground wires are largely responsible for this immunity from lightning.

The charging current of 130 miles of single line at 60 cycles and 100,000 volts at the generating end is 39 amperes per wire or 0.3 ampere per mile. This current was measured directly with a high voltage ammeter, and checks closely with the calculated charging current.

The insulators used are of the suspension type and consist of six units, 10 in. in diameter, and the under side of each unit corrugated. The caps and pins are cemented to the porcelain with Portland cement. The insulators have an ultimate strength of approximately 10,000 lb. and will flash over wet at somewhat over 300,000 volts. Up to the present time there has not been a single insulator failure, either mechanical or electrical.

It is true that shortly after the line was erected an insulator was shot in two by a high powered rifle, the bullet cutting a deep groove in the forged steel pin, cutting in two the clevis ears and destroying the porcelain of one unit. This, however, could hardly be classed as a failure.

No difficulty has been experienced with the insulators swinging in the wind. With a 60-mile wind blowing at right angles to the line it is believed that the insulators will swing side-ways and stand at an angle of approximately 40 deg. with the vertical. The maximum deflection observed so far, however, has not been over 30 deg. A considerable deflection has been noticed in insulators which are located between a long span and a short span due to changes in temperature. The tension in a short span varies more with changes in temperature than does the tension in a long span, consequently during cold weather the insulators deflect along the line toward the short span while in hot weather the deflection is in the opposite direction. This action deserves considerable attention, and to accommodate the different positions of the insulator at different times of the year a wire clamp should be employed with a long bearing surface on the wire and a relatively short distance between the wire and the hinged point which supports the clamp. This form of clamp is desirable to prevent a sharp bend in the wire when the insulator stands at either extreme of its swing.

The line is controlled at each end by 100,000-volt oil switches, solenoid operated, having a double vertical break. The switches are top connected through oil filled bushings. These switches have been entirely satisfactory and have readily broken the short circuit current supplied by the 21,000 kilowatt plant feeding the lines. To sectionalize the line out-door, double air break switches are used of the three-pole, revolving arm type. The switch blades and jaws are mounted upon pedestal insulators made up of six insulator units in series very similar to the regular suspension insulators except that the cap of one unit is extended upward to form the pin of the next, thus making the insulators as a whole rigid. These switches have not as yet been used to break any charging current but from the standpoint of good insulation and mechanical strength and ease of operation, they have been very satisfactory.

The charging current of the line is at present entirely supplied by the main generating plant, which has a total capacity of 21,000 kw., divided into six generating units of 3500 kw. each.

The output of two generating units is utilized near the generating plant, consequently there are at present installed only four banks of 100,000-volt step up transformers, each bank having a capacity of 3,600 kw. The charging current one line is well above the normal rated capacity of one generating unit. It has been found, however, that one generating unit and bank of transformers can readily supply the charging current of one line for a short time.

The plant is now fully loaded with an induction motor load and the lagging current taken by the induction motors so nearly balances the charging cur-

[1]Paper presented at the 28th Annual Convention of the American Institute of Electrical Engineers, Chicago, Ill., June 26-30, 1911.

rent of the line that the power factor at the generating plant averages 99 per cent.

There are installed in Butte three 1200-h.p. synchronous motors direct connected to air compressors. These are not yet connected to the line but will be in a short time, and it is expected that they will aid slightly in regulating the voltage at Butte.

The 100,000-volt outlets at the Rainbow Plant and at the Butte substation, as well as the switching station at the middle of the line, are through the roofs of the buildings. Oil filled porcelain bushings are used, and these have proved entirely satisfactory. All transformer bushings and switch bushings are oil filled and as yet have caused no trouble.

Electrolytic lightning arresters are used at both ends of the line and in the middle, the latter being installed in the switching station. These arresters have discharged during lightning storms, and usually discharge when any high tension switching is done.

The original pedestal insulators upon which the horn gaps for these arresters were mounted proved weak mechanically. Two insulators broke off at the bottom connection without apparent cause. These have since been replaced with the type of insulator used on the line-sectonalizing switches and no further trouble has been experienced.

The line has successfully withstood winds estimated at 60 miles per hour, and has been through one sleet storm where sleet formed on the wires "to a diameter of six inches," as reported by one patrolman. This, however, was doubtless an exaggeration.

When the line was first put in commission corona was plainly visible on every live part of the system. The corona gradually became less until after about three weeks no corona at all was visible except in a few places in the stations, such as the points of switch blades and other sharp projections. It is believed that this corona formed on small points or other roughnesses caused by the rough handling of the wire and that these have gradually worn off or burned off.

A private telephone line parallels the transmission line from Great Falls to Butte. This line is erected on wooden poles and runs midway between the two tower lines at a distance of 30 ft. from each. There was considerable static and much noise on this line when first put into operation. Reactance coils bridged across the line with their middle points grounded were installed at each end of the line and in the middle, and these reduced the induced voltage to about 50 volts between wires and ground, and did away almost altogether with the noise. The line now gives excellent service, and is easier to talk over than the lines of the Bell Company.

At no load there is a rise in voltage on the line of 3.5 per cent. With a load of 15,000 kw. at 85 per cent power factor on the two lines the drop in voltage is 7 per cent. With all this load on one line the drop in voltage is 17.5 per cent. Taps are provided on the high-tension winding of the step-up and step-down transformers, and the step-down transformers are connected on a 10 per cent lower tap than are the step-up transformers thus compensating for a drop of 10 per cent. When it is necessary to carry the full load on one line the generating plant raises its voltage 10.5 per cent to take care of the additional drop.

The switching station, which has been referred to, will provide a cross-over in the middle of the line so that it will be necessary to cut out only half of one line in case of accident. This will considerably improve the regulation of the line as a whole.

The towers have four legs and a single horizontal cross arm. The wires are supported at the two ends and in the middle of the cross arm and hang 40 ft. from the ground at the tower. The cross arm is supported at two points, each midway between the middle wire and the outside wire. The two ground wires are supported above the cross arm near its points of support.

The tower is composed entirely of angles and flats, all connections being by means of bolts. The cross arm is made of two 4-in. channels placed back to back and separated in the middle. The tower is erected on four angle iron stubs set six feet in the ground, the bottoms of these stubs terminating in flat feet made of short pieces of channel section having an area of 144 sq. in. each. All parts of the tower are galvanized.

The system has been operating at 100,000 volts for six months and nothing has developed as yet to indicate that the operation of a 100,000-volt system is any more difficult than the operation of a 50,000-volt system. On the other hand, it is believed that the extra high insulation provided for this voltage prevents many break downs, due to lightning and surges, which would occur on a system operating at 50,000 or 60,000 volts with insulators designed for a factor of safety of two or three, as is common with such systems.

After all, the normal voltage of a long transmission system has little to do with the voltage which must be insulated against. It is the abnormal voltages, caused by lightning, switching and accidental grounds, which really test the insulation of a system such as this.

CHINESE IRRIGATION PUMPS.

Machines for raising water for irrigating purposes are constructed entirely of wood, long chains of paddles running from the stream to a wooden shaft whose wooden cogs fit into others on a wooden wheel on shore. This wheel is turned by a water buffalo, which blindfolded to prevent dizziness, plods in slow circles, supplying the power that brings the needed current to the level of the fields. This machine and the buffalo are the most important possessions of the farmer in China; the latter has probably been bred on the premises and the former constructed by the village machinist at small cost, so that little coin value is represented.

On farms too small for the buffalo and wheel it is usual to see two men with a scoop of closely woven bamboo, swung between them on a rope of the same material, keep a stream of water moving from one level to another for 10 minutes at a time, resuming operations after a short rest of about 5 minutes. It is said that these men raise not less than 1500 gallons of water per hour.

Besides turning the irrigator, the buffalo also turns the stone to grind rice into flour, pulls the plow, and, if female, supplies milk to the family. This animal is both horse and cow to the local farm.

SOME UNEXPLORED FIELDS IN ELECTRICAL ENGINEERING.[1]

BY DR. C. P. STEINMETZ.

In discussing the subject of the unexplored fields of electrical engineering, we must consider as belonging to the realm of the electrical engineer, all those phenomena of electricity that are of importance to man; those which are beneficial and useful, and utilized in doing the work of the world, and also those phenomena which are harmful and destructive, and therefore to be guarded against.

In some fields of electrical engineering or of electrical science we might almost say that we know less now than we knew, or rather believed we knew, a quarter of a century ago. There are things which had been investigated a quarter of a century ago and which were explained in a satisfactory manner to our limited knowledge in the early days, but this explanation does not seem satisfactory now with our greater knowledge.

A curious example we might cite from the textbooks on natural history, for instance. There are supposed to be some fishes which are capable of giving electric shocks. There are some species of gymnotus in the South American mud creeks capable of imparting electric shocks, which have been described a number of times, fishes which have an organ which generates electricity. It has been described as being constituted like a Volta-pile, of a number of successive cells. That theory was quite acceptable twenty-five years ago, but is not satisfactory now. To give a severe shock would require about 500 to 1000 volts, and it is not intelligible how such voltage could be generated in the conducting animal tissue without being short circuited. Furthermore, the fish is immersed in water, which is a fair conductor, especially sea water, and 500 volts or more would produce hundreds of amperes in the surrounding water, representing hundreds of kilowatts, and it is not intelligible how such a large power could be generated even momentarily. Thus here we have a mystery, because, after all, the descriptions have been so concise that it is difficult to doubt that there are fishes which can give electric shocks. Just why that phenomena has not been investigated by electrical engineers, we do not know, especially when considering that one of the electric fishes, raja torpedo, lives in the Mediterranean and is frequently caught on the Italian shores, as claimed, thus is within easy reach of engineers.

But we do not need to go so far from home; right at hand we have some of the most important uninvestigated phenomena of electricity. The thunderstorm, the lightning, and so forth. In the early days lightning was explained as the discharge of the clouds. The clouds are positively charged, and the ground is negatively charged, and the spark jumps from the cloud to the ground. Speculations were made as to how the clouds became charged, and as then the only method of producing electricity was by friction, it was said it might be the friction of the vapor through the air, or the rain drops through the air, or some other form of friction. That explanation used to appear satisfactory, but with our present knowledge of dielectric phenomena, it is not satisfactory any more.

It was thought that lightning was the discharge from the cloud to the ground. That means that the electric field between the cloud and the ground must be beyond the breakdown strength of air. In a uniform field the breakdown strength of air is about 75,000 volts per inch, or nearly a million volts per foot. Even if the cloud is only 1000 feet above ground, this would require a thousand million volts. If there were an electrostatic field between the cloud and the ground of a thousand million volts extending over the whole area of the thunder cloud, this would represent such an immense amount of electric energy that it is inconceivable how any reasonable source of energy can produce it, how it can exist without having a destructive effect far beyond anything known of lightning. Furthermore, a uniform field cannot well exist between clouds and ground, on account of the unevenness of the ground surface.

We cannot consider the lightning discharge as a simple electric rupture in the same way that an overloaded beam may break mechanically, but as an equalization of internal stresses, about as a piece of hot glass that is rapidly chilled, and thereby full of internal compression and tension strains may suddenly break all over by the internal stresses. So with our present knowledge we must consider as the most probable explanation—although not certain by any means—that the lightning discharge is the phenomenon of the equalization of internal electric stresses in the cloud, and is analagous to the splintering or breaking of an unevenly stressed brittle material, like glass.

Lightning discharges are the result of the voltage inequalities produced in the clouds by the unequal rate of conglomeration of rain particles due to the unequal cloud density.

In agreement with this is that heavy lightning strokes are usually followed by a heavy downpour of rain; in reality they are preceded and caused by it, but it takes time for the rain drops to come down.

The lightning rod is a great protection, and I would not like to be in an exposed place without such protection. But you must not expect that one rod on one end of the building will completely protect the other end a hundred or more feet away. There must be sufficient rods to extend their protective zone over the entire area; the apex of the roof, and other projecting edges must be protected by connecting wires, etc. That is, like any other apparatus, the lightning rod protection must be installed intelligently and properly to be effective. But the general principle is correct, only it must be rationally applied.

We now find that in the study of electrostatics the conceptions of the work of former days is untenable, from our present point of view; we cannot conceive of the dielectric phenomena as a charge on the conductor surface; we know there is not an electric charge on the conductor, the dielectric energy resides not on the conductor surface, but is in the space around the conductor in a dielectric field, and the so-called "charge" is nothing but the termination at the conductor surface of the electrostatic field in space.

[1]Abstract of paper presented at the joint meeting of the Electrical Section of the Franklin Institute, Philadelphia, and the Philadelphia Section of the American Institute of Electrical Engineers, and printed in the June number of the Journal of the Franklin Institute.

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CONTENTS

Exposition Site

Although we have formed decided views regarding the proper location for the big Panama-Pacific Fair, we are inclined to allow the proper persons, acting in their public-spirited manner, decide this important question. The Fair Commissioners are eminently qualified to make the selection best suited to the requirements of this great project and when the site is chosen let everyone forget the discussion and differences that have arisen and become boosters for the greatest exposition ever undertaken. Exploitation of all Pacific resources should be the password. Above all, however, we are most interested in the especial exploitation of Western power developments and there should be such an electrical display put forth that the whole world will ever carry in mind this dazzling picture of supremacy.

Transmission Line Charts

The cumbersome and intricate formulas necessary in the study of alternating current phenomena have either led many engineers to other fields of research or limited them in a proportionate advance in this branch of the profession. To completely analyze a transmission system under given conditions at the receiving end is a problem requiring the utmost skill and care in computation. A signal advance was made in the profession when Harold Pender and H. F. Thompson worked out the equations from which the charts presented in this issue were drawn.

There are many engineers who are not given to reasoning in symbols. Give them charts so they can readily work out concrete examples and thus study the relationship from this point of view and they are quite at home. Many of our most practical men are of this type. It may develop that for many cases these charts cannot be read to a sufficient degree of accuracy to use in practice. Should this prove to be the case they will nevertheless be of inestimable value in checking up many kinds of computation in transmission line data. Hitherto there has been nothing to serve as a check in this work.

New Method Land Appraisement

The question of a proper valuation of property in case of condemnation proceedings at court is difficult of solution. On the day set for trial it is usual to see each side marshalling its forces in preparation for the conflict. Each side introduces its set of expert witnesses who swear to the merits of their respective contention, although there is but one proper value. Sales of real estate in the vicinity are a great aid in arriving at a value and yet it is often the case that no sales have been recent enough to be acceptable. To get unbiased expert witnesses to establish the proper value is most difficult.

In the current issue of Engineering and Contracting, the editor, H. P. Gillettte, well-known as an expert on "cost data," has set forth a meritorious method which should command the respectful consideration of all interested in valuations. The author calls it "Capitalized Rental Method." The necessary steps in arriving at land values by this system are five in number. First determine the rental paid for real

estate contiguous to and similar to the property to be appraised. Second, estimate the cost of the buildings on the land whose rental price is known. Third, estimate the fair annual rental for the capital invested in the buildings alone, and to this add insurance, taxes and annual depreciation of buildings. Fourth, deduct this total from the total rent received for the land and buildings, and the balance will be the land rent and the amount thus ascertained is the value of the land.

This suggestion adds much toward a proper determination of appraisement for particular prices of land and especially is it useful in well-established localities in cities. It seems, however, almost impossible in many of the newer localities of the West to use any particular rule or method. A favorite scheme used by witnesses for the defendant in a case of considerable local interest near Missoula, Montana, some three years ago when the Northern Pacific Railroad Company and the Chicago, Milwaukee and St. Paul Railroad desired a joint right-of-way through a certain widow's property, was to capitalize the rental on a fruit-bearing basis. The land was only of moderate fertility, with but a small portion planted to apple trees, and by public road six miles from town, yet this plan, backed up by the blushing appearance of the widow and her children in court, led the Board of Appraisers to award her over $40,000 for the strip desired.

The method of showing the productivity of land and its earning capacity in the West is subject to so many fallacies that it should be used with great care. Even on the basis of potato yield the land can be shown to have enormous values, yet the rentals themselves do not give such return, year in and year out, on this basis of calculation. As years go by and conditions become more settled no doubt this method for farm values will prove of service. It is to be hoped that some satisfactory means, similar to the Capitalized Rental Method in cities, can be worked out for the rural districts throughout the West. As land values are so fluctuating and uncertain it is doubtful whether this can be accomplished with any degree of accuracy. Consequently the great corporations desiring rights-of-way, will in a large measure have to endure exorbitant costs.

Engineer's Relation to Teaching

No other technical profession is subject to such continuous changes in theory and practice as is that of electrical engineering. Being a profession built up within the past two decades, it still has the energy and vigor of youth, with a future bright before it. Unquestionably, during the next two decades it will experience even greater and more radical changes. It seems but yesterday since there was completed the installation of Louis Bell that transmitted power from San Antonio Canyon in Southern California to the city of San Bernardino, some twenty miles away. How the neighboring people used to swell with pride as they informed awe-inspired visitors that this was the longest electrical transmission line in the world! Compared with the present giant lines in the Sierras and Rockies, with distance of transmission running into hundreds of miles and voltages reaching the hundred thousand mark, the human mind can scarcely grasp the fact that twenty years could so enlighten a profession as to lead men to dare to accomplish such a control of natural forces.

In fact, changes are coming so rapidly, that what was yesterday's theory and practice is discarded today as so much mental and material junk. To keep pace with this gigantic development and to carry it to still farther heights requires the best brains and talent in the profession, and the designing and installation of these enterprises have developed some of the brightest minds of the nation. The great industries have vied with each other in their search for brains. So constantly are new methods replacing the old that a necessary innovation is introduced in the teaching of the profession in the universities. The impetus of this great movement made itself felt upon the university life, first, by taking away from the technical institutions many of their brainiest men. Of all the professions in America to-day, the highest, that of the college professor, is uniformly recognized as the least remunerative.

The great industries have gone far and wide in search for their experts. These experts become not only captains of industry, but invent and conceive new ideas and theory regarding the engineering profession. In the great technical schools there is felt the utmost need for men of theoretical natures but eminently practical. Students looking forward to practical life need men ripe in experience for maximum benefit, yet the comparatively small salaries paid in our American university faculties have made their technical department sadly in danger of losing their brilliant men.

It is gratifying to note that a new era is dawning upon our educational developments. The happy thought of retaining engineers of note or of calling such men to university chairs and allowing them to combine in a definite manner university work with outside practice seems to be adjusting itself more and more. The time is past when the college professor can wilfully neglect his college duties to engage in outside practice. Many unfortunate experiences of the past have demonstrated this, but purely theoretical engineers are of little service either to the university or the engineering profession. An opportunity to put theory into practice is essential. A different arrangement whereby it is strictly understood that university work is in no wise to suffer by such practice as may be undertaken and that university work is to come first seems to bring about maximum good results. Thus is presented to the student for his instructor, well-rounded engineers, up-to-date in practice and up-to-date in theory.

The more this combination can be crystalized, the more will the university chair attract our great engineers. With part of their time to deal in theory and part for consulting work they will feel that the sacrifice financially is not too good and thus will result for the young engineer the highest type of engineering instructor.

Illustrations of this late idea are numerous. C. P. Steinmetz has been called to Union College, Wm. Kent to Syracuse University, and last, but not least, Chas. F. Scott to head the electrical engineering department at Yale.

PERSONALS.

F. F. Skeel, of the Crouse-Hinds Company, is at San Francisco.

F. G. Baum has returned to his San Francisco office from Shasta County, Cal.

H. H. Sinclair, formerly manager of the Great Western Power Company, is at Los Angeles.

C. Gaylord, an electrical engineer of Pasadena, was a San Francisco visitor during the past week.

K. G. Dunn, electrical engineer with Hunt, Mirk & Co., spent the past week at Denver on business.

F. A. Cressy, who has electric lighting interests at Modesto, was at San Francisco during the past week.

Edward Averill, the Portland manager of the Forbes Supply Company of Seattle and Portland, is at San Francisco.

M. C. Miller, assistant to the president of the Allis-Chalmers Company, arrived at San Francisco last week from Milwaukee.

Hugh L. Thomas, superintendent of the Salt Lake Telephone Company, was at San Francisco during the past week.

H. B. Squires, of Otis & Squires, San Francisco, is receiving tne congratulations of his friends on the arrival of a daughter.

W. S. Hoag of the Los Angeles office of the Westinghouse Electric and Manufacturing Company, was a recent San Francisco visitor.

H. A. Sayles, with the Holabird-Reynolds Company, went to Santa Catalina Island to attend the State Convention of the Electrical Contractors' Association.

J. E. Woodbridge, engineer in charge of the San Francisco office of Ford, Bacon & Davis, engineers, recently returned from a vacation tour to the Hawaiian Islands.

Mr. Ames, head of the National Electric Company, was one of the San Francisco delegates to the Electrical Contractors' Convention at Santa Catalina Island.

Edward Ayden, auditor of the Portland branch of the Pacific States Electric Company, returned to Oregon during the past week after visiting the main office at San Francisco.

Leon M. Hall returned to his San Francisco office during the past week from a trip to Reno in connection with the engineering work on an electric power development in Nevada.

W. W. Low, president of the Electric Appliance Company, celebrated his silver wedding anniversary by a dinner to a large number of friends at the South Shore Country Club, Chicago.

Samuel Napthaly, general manager of the Great Western Power Company, has returned from a trip to the new dam site at Big Meadows, in company with P. T. Hanscom, general superintendent.

W. S. Hanbridge left last Saturday by steamer for Los Angeles, with a large party of excursionists representing electrical firms, who went south to attend the convention of Electrical Contractors at Santa Catalina Island.

H. D. Donnell, assistant manager of the Safety Car Heating and Light Company of New York, returned to his San Francisco office last Monday after an extensive Eastern tour. He attended the conventions of the Master Car Builders and the Master Mechanics at Atlantic City, besides visiting several manufactories.

John Ripley Freeman, a past president of the American Society of Mechanical Engineers, and consulting engineer for the New York Board of Water Supply, recently arrived at San Francisco, where he is engaged in a consulting capacity by the city government in connection with water works investigations. Allen Hazen, a prominent New York engineer, preceded him to the city, having been employed by the Board of Works to examine and make a report on the water supplies of San Francisco from a filtration standpoint.

W. S. Heger has resigned as manager of the San Francisco and Los Angeles offices of the Allis-Chalmers Company, his duties being assumed by Fred L. Webster, newly appointed Pacific Coast manager for the company. He has endeavored t bring this about for nearly two years and will now retire from active business life, making his home in Marin County, California. Mr. Heger is one of the pioneers in the machinery business on the Pacific Coast, having opened the San Francisco offices of what has since become the General Electric Company in 1889. Resigning in 1891 he went East, but returned in 1895 to establish the office of the Westinghouse Electric & Manufacturing Co., being Pacific Coast manager until 1905, when he resigned to become assistant to the president of the Allis-Chalmers Company. In 1909 he returned to the Coast to take charge of their California business. It is with heart-felt regret that his many friends have learned of his decision to retire and it is their sincere hope that he will find pleasure in rest.

Fred L. Webster, who has just taken charge of the Allis-Chalmers Company's Western interests, with the title of Pacific Coast manager, will make his headquarters at San Francisco, visiting the branches at Los Angeles, Portland and Seattle from time to time. His jurisdiction will extend from the Mexican boundary north, including Alaska. After building up his company's business in the Northwest during the past few years as manager of the Seattle office, Mr. Webster comes to San Francisco well equipped for the management of the entire Pacific Slope. Although Mr. Webster is already well and favorably known in engineering circles, a sketch of his previous career may be of interest. He joined the E. P. Allis Company in the erecting department, in 1892. Subsequently he did a great deal of foreign work for their factory, spending four years in South Africa. On his return from Africa, in 1891, he became chief engineer of the St. Louis Transit Company, holding that position until 1893. Then he went with the Fulten Iron Works, St. Louis, as sales manager, handling Corliss engines principally. In 1895 he returned to the Allis-Chalmers Company and was for two years head salesman of their Chicago office. Then he came to the Coast as manager of the Seattle office, which position he has held for the past three and a half years, his territory covering Washington, Oregon and British Columbia.

TRADE NOTES.

The Aylesworth Agencies Company of San Francisco has taken on the line of the Steel City Electric Company, of Pittsburg, including lock nuts, conduit boxes, etc.

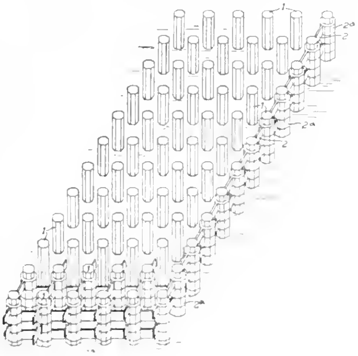
The General Electric Company has sold to the Robinson Manufacturing Company, of Everett, Wash., a condensing Curtis turbine rated as follows: One A. T. B. 2, 750 kw., 3600 r.p.m., 480 v., horizontal, Curtis turbine generator.

NEW BULLETIN.

The Kelman Electric and Manufacturing Company of Los Angeles are distributing through Pierson, Roeding & Co., Bulletin No. 7, which deals with high voltage oil switches and oil circuit breakers. The bulletin is profusely illustrated with various types of switches from 75,000 hand operated to 30,000 volt apparatus. Sectional details are shown of the interior workings.

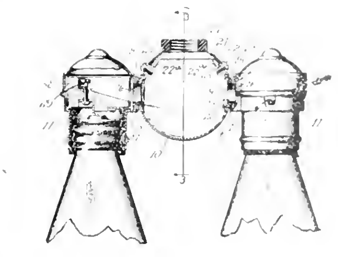
PATENTS

996,843. Seawall or Wharf Construction. Charles F. Francisco, San Diego, Cal. A seawall or wharf construction comprising, a plurality of reinforced concrete piles spaced apart,



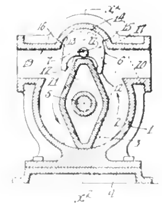
a plurality of reinforced concrete locking and interlocking collar beams, and a plurality of ball bearings adapted to reduce the friction of vessels in contact with said piles, all substantially as set forth.

996,963. Electric-Lamp Cluster. Reuben B. Benjamin, Chicago, Ill., assignor to Benjamin Electric Manufacturing Company, Chicago, Ill., a corporation of Illinois. An electric lamp cluster comprising a hollow supporting body having a plurality of apertures therein; a plurality of lamp sockets, each lamp socket having a casing shell formed with a hollow boss ex-



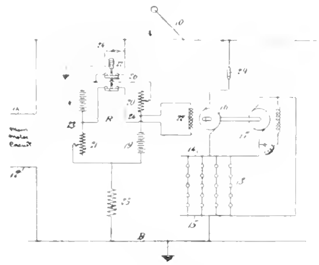
tending at right angles with the axis of the lamp and having an aperture formed therein; and means for securing the outer faces of said hollow bosses directly against the outer surface of said supporting body in such manner that the apertures of the bosses will respectively register with the apertures of the supporting body.

996,984. Pump. John Grindrod, Bakersfield, Cal. In a pump, the combination of a casing provided with an inlet and an outlet and having a cylindrical chamber and a channel therebetween, an elliptical runner rotatably mounted in the casing, and an abutment rotatably mounted in said channel and provided with two lips, each lip being of a greater length from the pivot of the abutment to its tip than from said pivot to the wall of the channel, but of a less length than the distance from said pivot point to the junction of the wall of the chamber and the walls of said inlet and outlet, respectively, whereby the pressure of the fluid being expelled will hold one



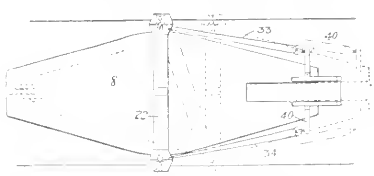
lip in contact with the runner at all times without causing the other lip to close the inlet.

996,894. System of Electrical Distribution. Emmett W. Stull, Milwaukee, Wis., assignor to Allis-Chalmers Company, a corporation of New Jersey. In combination, a circuit of variable voltage, a second circuit supplied therefrom, a generator in the connection between the two circuits, and a Wheatstone bridge connected across the circuit of variable



voltage and having arms in opposite ones of which the drops in voltage vary proportionately and in adjacent ones of which the drops in voltage vary disproportionately as the voltage of the variable voltage circuit varies, the field winding of said generator being connected in the bridge wire of said Wheatstone bridge.

997,247. Dredge. Walter Ferris, South Milwaukee, Wis., and Paul Revere Parker San Francisco, Cal., assignors to The Bucyrus Company, South Milwaukee, Wis., a corporation of Wisconsin. A dredge having an anchoring structure pivoted to



the deck thereof, power operated mechanism connected directly with said structure and by means of which the dredge is swung laterally in either direction with said anchoring structure as a stationary pivot, and excavating mechanism carried directly by the dredge hull.

INDUSTRIAL

SELECTIVELY OPERATED SEMAPHORE AND TELEPHONE EQUIPMENT.

Since the development of the telephone for train dispatching, a need has been felt for signaling equipment which could be used and operated in connection with a telephone train wire. That is, instead of having a selector on a telephone circuit ring a bell at a way station, it was required that it should throw a semaphore arm. The Western Electric Company, in conjunction with the Union Switch and Signal Company, has for some time been developing apparatus to meet this particular need, and a description of the new apparatus and its uses is given here.

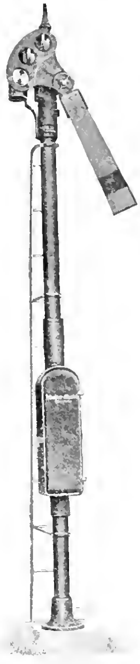


Fig. 1. Signal Post.

Both steam and electric railroads offer an extensive field for use for this selectively operated semaphore in connection with the telephone system. On steam roads it will probably be used exclusively for train order work. In other words, it will be employed as an auxiliary to a regular telephone train dispatching system. When used in this way it will secure a still further saving than is now effected by the telephone.

The new Western Electric semaphore has some new features which are of particular interest. In Fig. 1 is shown the outfit complete. The semaphore proper is of standard make and can be furnished in either the upper or lower quadrant types, as desired. A three spectacle casting is provided. The semaphore, selector and telephone equipment are all mounted on the same iron post, and the apparatus is self-contained. The weatherproof box is locked, so that access is obtainable to it only by means of keys which would be furnished to the proper parties. The semaphore blade itself can be furnished of any type or shape desired to conform to the practice of the railroad buying the equipment.

Everything is arranged for facilitating maintenance work. Ample size terminals are used throughout in the apparatus, and practically all maintenance connections inside the casting are made with terminal screws or hexagonal lock-nuts. The wiring throughout is of copper insulated weatherproof braided wire, in conformance with good signal practice. All the telephone apparatus is water-proofed to withstand moisture. All wood used in the interior of the set is oil treated. The telephone and selector are enclosed in an inner compartment. All openings are arranged so that water cannot enter the set. In addition, the outer door of the set has a weather-proof gasket, rendering it practically impervious to moisture.

Fig. 2 shows the pole casting containing signal mechanism, the telephone and selector equipment. The signal mechanism is of the electrically operated type, but is manually restored. The relay operating this is normally de-energized, and ten dry cells are required for its operation. As this relay will operate on four cells, it is obvious that an ample margin of operation is allowed.

The signal mechanism proper is contained in the compartment at the top of the casting. The only part of this which appears on the surface of the inside door is the handle

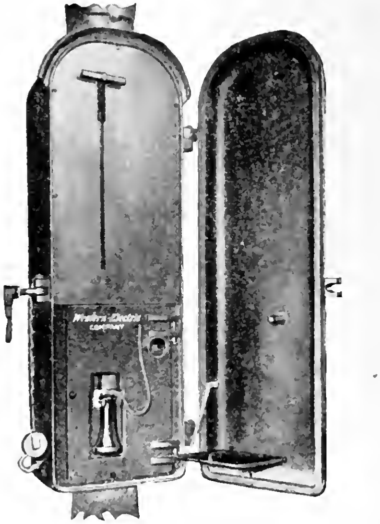


Fig. 2. Outer Door Open.

of the restoring lever. The selector and terminals are readily accessible for maintenace purposes.

One important feature of the selectively operated semaphore is the fact that it gives to the dispatcher an answer

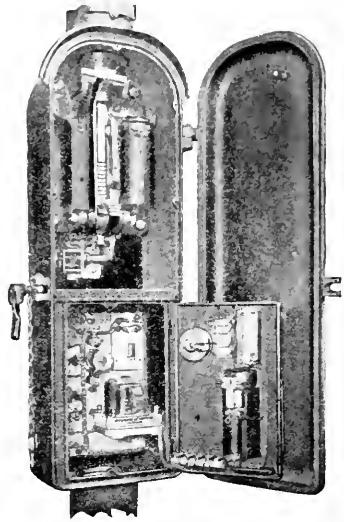


Fig. 3. Inner Door Open.

back which cannot be mistaken, telling him that one particular semaphore has completed its movement and is at the "stop" position at the time the answer-back is received.

The telephone set is especially designed for railway work, and is of high efficiency. The transmitter and receiver are mounted on the outside of the inner door, on the lower part of the apparatus casting. The transmitter mouthpiece is of metal and so fastened in the set that it cannot be removed without opening the inner door. All parts are arranged so that they can be easily inspected and maintained, and they are of the usual "Bell" grade quality. All metal is given a black finish, which eliminates any chance of rusting.

The signal mechanism is operated by the Western Electric's latest development in railway selectors. This selector is practically independent of weather conditions and absolutely reliable. It is in operation at the present time on eighteen of the largest railroad systems in this country, where it is giving universal satisfaction.

Fig. 3 shows the apparatus casting with the inside cover open. In this illustration will be seen the arrangement of the selector and terminal apparatus on the inside of the casting. The signal mechanism as shown above, together with the manually operated lever and the gears by means of which the semaphore blade is restored to the "Clear" position. The outside door of the apparatus casting is provided with a sheet iron writing shelf which will be a great convenience [illegible] down orders from the dispatcher.

The circuit arrangements of the signaling equipment above described are very similar to the standard train dispatching circuit. The dispatcher operates selector [illegible] the same manner; instead, however, of a bell ringing at the point called, a semaphore blade moves to "Stop." The [illegible] signal returns to the dispatcher [illegible] and then it waits for the crew of the train [illegible]. Should he be disconnected from the [illegible] the crew can easily call him, but [illegible] does not require this. Only one pair [illegible] to extend along the line. As many sets as [illegible] be connected to this circuit, and it is used [illegible] and signaling. All equipment is bridged direct [illegible] circuit, and any piece of apparatus can [illegible] line without affecting the rest of the equipment.

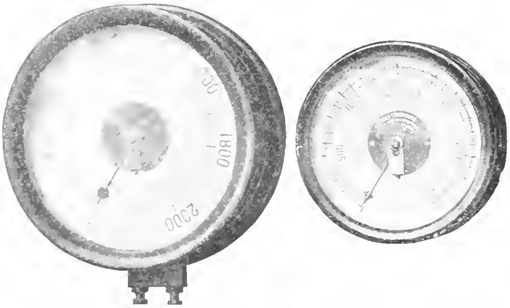
The use of these instruments affords a [illegible] flexible system, for as many semaphore [illegible] one telephone circuit as necessary, in addition [illegible] phone apparatus.

If desired, standard telephone [illegible] at other points along this circuit where [illegible] not located. This semaphore equipment can also [illegible] on existing train wires which are being [illegible] the telephone. In addition to being exceedingly [illegible] use of these semaphores insures an accurate, [illegible] and economical method of handling trains [illegible].

NEW TYPES OF SWITCHBOARD METERS.

The increasing size of modern power [illegible] and the growing capacity of available space [illegible] cities, have emphasized the need of [illegible] switchboard design. The desirability of having [illegible] in plain view of one operator has long been [illegible] and this requirement necessitates meters that shall [illegible] a minimum of space and at the same time be [illegible] ble from a distance. In many plants in congested [illegible] the switchboard is located in a poorly lighted [illegible] imposes the further requirement that the [illegible] able of thorough illumination. Accuracy and the possibility of making repairs quickly and easily on the [illegible] features that every power plant manager requires.

In line with these strongly defined tendencies [illegible] switchboard design, the Westinghouse Electric & [illegible] ring Company, East Pittsburg, Pa., has developed [illegible] alternating current and direct current switchboard [illegible] nts, which, for their novel features, are of extreme [illegible]. The new meters comprise a complete line of seven-inch meters and a complete line of nine-inch meters. The seven-inch alternating current meters, known as the type SM, and the nine-inch, known as type TM, are built as ammeters, voltmeters, wattmeters, power factor meters, frequency meters and synchroscopes. The corresponding types SL and TL direct current meters are built as ammeters and voltmeters. The completeness of these lines make it possible to design an entire switchboard with one uniform type of meter, either seven-inch or nine-inch throughout.



[illegible] Type [illegible] Wattmeter and [illegible]

The scales of both sizes of alternating current meters are [illegible] long. This remarkable scale length is as great as [illegible] only in large illuminated dial meters, and [illegible] than that obtainable with edgewise meters that occupy [illegible] room on the switchboard as these seven-inch meters [illegible] economy of space in comparison with the [illegible] is shown in the following tabulation:

[illegible] Type SM covers a rectangle 55 sq. in.; scale $11\frac{1}{2}$ in. [illegible]

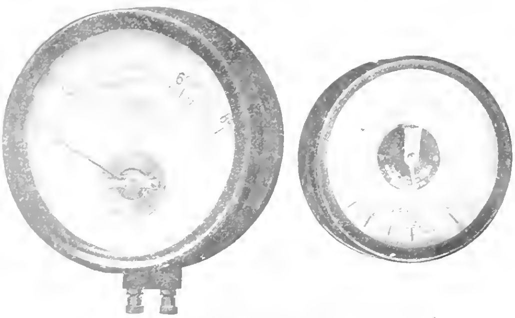
[illegible] Type TM covers a rectangle 107 sq. in.; scale $11\frac{1}{2}$ in. [illegible]

[illegible] inch meter round pattern, 107 sq. in.; scale $7\frac{1}{4}$ in. [illegible]

[illegible] edgewise meter covers 55 to 80 sq. in.; scale 12 in. [illegible]

[illegible] edgewise meter covers 52 sq. in.; scale 6 in. long.

This long scale feature is not depended on alone to make [illegible] easily readable. Instead of the usual metal front,



[illegible] of [illegible]

[illegible] is used [illegible] it possible to thoroughly [illegible] the dial [illegible] out the trouble [illegible] with the curved covers [illegible] types of meters, and enables the whole [illegible] thereby [illegible] it possible to take accurate [illegible] from a distance and from any angle.

These features of compactness and readability of the new 7-inch meters, combined with the perfectly damped indications and important improvements in the electrical design, mark a distinct advance in switchboard meter practice. The type TM 9-inch meters embody the same improvements and meet the demand for a larger meter where economy of space is not a prime consideration.

These meters have no moving coils or connections, as they operate on the induction principle; a rotating magnetic field, produced by current in stationary windings, acts on a light metal drum.

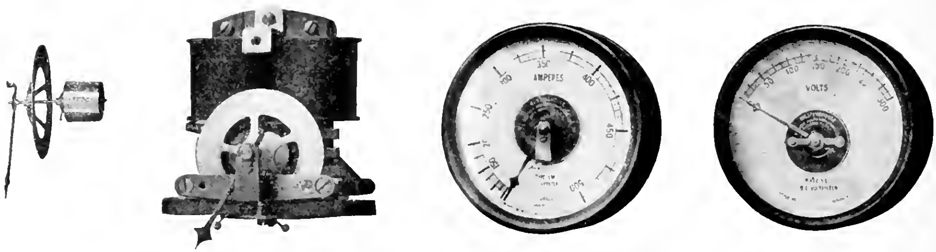
The construction of meters on this principle has a number of inherent advantages. The absence of a moving coil makes the use of flexible or sliding conductors unnecessary, and greatly simplifies the construction so that repairs are easily made. The lightness of the moving element makes the likelihood of damage to the pivot jewels remote, and reduce jewel wear to an inappreciable minimum. It is well known how seriously the proximity of heavy bus bars affects moving coil and moving iron instruments, even when special internal shields or iron cases are provided. Freedom from the effects of external field, and high torque, are among the advantages gained by utilizing the induction principle. This principle has now come to be recognized as the most practicable principle in the case of alternating current watthour meters, and it is reasonable to assume that the perfected induction indicating instruments will in time replace all other types

stationary support, all moving parts except the shaft are of aluminum, and the pointer is an aluminum punching of U-cross-section. On the other hand, wherever weight is required for strength it is present. The result is a moving element heavy enough not to be delicate, yet light enough to cause no damage to the jewels during shipment and to cause no wear in use. The ratio of torque to weight is higher than has ever been obtained before in commercial measuring instruments. The meters are therefore highly sensitive and accurate without being delicate.

The fact that the meter element can be removed from the case as a unit, allows all parts to be inspected without changing the calibration. The parts can be very easily removed and replaced, and the absence of moving coil or flexible connections makes this possible without danger of damage.

In these meters the previous designs of Westinghouse indication meters have been thoroughly revised to eliminate the effects of temperature changes, either of the air or of the meters themselves, and inaccuracies due to variations in frequency. The frequency meters, power factor meters and synchroscopes are of the well-known Westinghouse types with the added improvements developed for the rest of these lines.

The Types SL and TL direct current meters, supplement the line of alternating current meters and match them very closely in appearance. They have glass covers, the same types of cases and similar dial appearance, with scales 8 inches long. In fact the scales of the seven-inch meters are



New Type Switchboard Instruments Westinghouse Company.

for switchboard service, as completely as the induction watthour meters have replaced all other types, and for the same reasons.

A remarkable feature of the meters is the perfectly damped character of the readings. The pointer does not overshoot, even with full scale variation. This remarkable result is not obtained at the expense of accuracy, but by providing a special damping disk moving in the concentrated magnetic field of two permanent magnets. This "superdamping" of the indications will be particularly appreciated by those using meters on circuits or generators operating in parallel, where there is likely to be a rhythmic interchange of power, or pumping. The damping required to prevent wide oscillations of the pointer on such service can be obtained only by means of permanent magnet dampers. Compared with air dampers this method is not only more efficient, but so rugged in construction as to be practically "foolproof."

Exceptionally high torque is developed in the meter, and this makes possible the use of substantial controlling spring. This spring is of a special alloy and is tempered and artificially aged to insure permanence under all conditions. Extremely simple zero and calibrating adjustments are provided.

Extremes in weight have been avoided in these instruments. Wherever the principle of operation permitted, the weight has been made as small as possible consistent with substantial and serviceable construction. To this end the movement is made self-balancing to avoid the use of counterweights, the weight of the control spring is carried on the

as long or longer than those found in previous makes of 9-inch meters.

The meters operate on the D'Arsonval principle, a moving coil and fixed permanent magnets, which avoids all residual error. They differ, however, from most meters employing this principle in having only one gap in the magnetic circuit. The moving coil is pivoted at one edge, encloses a circular pole piece, and the other moves through the air gap. With this construction the moving element can be removed and replaced without disturbing the magnetic circuit, and the entire magnetic circuit is magnetized, "aged" and tested as a unit, thus preventing any variation in the strength. The shape of the permanent magnets is such as to shield the meter from external magnetic fields and make it free from effects from nearby conductors.

The moving coil is mounted on a light metal frame, the motion of which in the air gap of the magnets produces a damping effect that makes the readings practically dead beat. As the coil is pivoted at one edge, its weight counterbalances that of the pointer; resulting in a naturally balanced moving element. This leads to long life of pivot jewels and accuracy of reading. The meters have exceptionally high full load torque.

The dials of all the meters here described are hand calibrated on white cards, thus insuring extremely accurate scales. The divisions are clear and open and the figures large and distinct.

NEWS NOTES

FINANCIAL.

ALBANY, ORE.—Albert E. Wright, of Portland, has been granted a 25-year gas franchise in this city.

LEAVENWORTH, WASH.—The Washington Steel and Iron Company has been granted a 10-year light franchise.

GOLDENDALE, WASH.—Samuel Hill, owner of power sites in the Klickitat gorge, above Lyle, will shortly sell his holdings to the Northwestern Electric Company for a consideration of $20,000.

OLYMPIA, WASH. Bids will be received by the State Board of Control up to July 20th for one k.v.a. 2-phase 220-110-volt generator to engine. Specifications at office of Engineers Evans-Dickson Company, 725 Commerce street, Tacoma, Wash.

EUGENE, ORE. A bond election will be held here July 17th for a $57,000 issue for power plant extensions and water works construction. Providing issue carries, the city will extend its power wires and engage in active competition with the Oregon Power Company.

REDDING, CAL.—A trust deed and chattel mortgage for $2,000,000 has been filed for record here by the Anglo California Trust Company, of San Francisco. The deed and mortgage are given by the Sacramento Valley Power Company, of Redding. The sum is to be drawn upon as money is needed to extend the power company's lines down the valley. Fleishhacker Bros. of San Francisco recently bought a controlling interest, and it is understood that the company is shaping itself to extend its lines to San Francisco.

SAN FRANCISCO, CAL.—The merger between the Great Western Power Company and the City Electric Company has been completed. The transaction took place in New York City, where the first payment of $800,000 was made to the New York representatives of Herbert and Mortimer Fleishhacker of this city. The balance of $3,200,000 is to be paid very shortly. Herbert and Mortimer Fleishhacker become vice-presidents of the Great Western Power Company and have the active management of the corporation while Edwin Hawley, the New York railroad magnate and multi-millionaire, becomes its president. The company now owns one of the largest and most valuable water rights in California. With the properties just acquired of the City Electric Company, the Great Western Company is generating by its water and steam power plants about 100,000 h.p. When its new dam at Big Meadows is completed, creating an artificial lake thirty miles in length, it will have a sufficient volume of water to ultimately generate an additional 300,000 h.p. It is estimated that the total amount invested by the Great Western Power Company and its subsidiary companies aggregates about $20,000,000.

INCORPORATIONS.

ENTERPRISE, ORE. The Enterprise Electric Company has been incorporated for $50,000.

NEWPORT, ORE. The Yaquina Electric Company, Newport, Ore., has been incorporated for $20,000.

FRESNO, CAL. The Fresno, Coalinga & Monterey Railway, Fresno, Cal., has been incorporated for $4,000,000 at $50 per share; $200,000 subscribed.

BEAUMONT, CAL.—The El Caseo Water Company has been incorporated. The directors are: Henry Fuller, J. H. Fisher and Hoell Tyler, all of Redlands. The object of the company is to purchase, own, improve and develop land and water and to perform duties connected with water companies.

LOS ANGELES, CAL.—The West Ontario Water Company has been organized and incorporated in this city by a large number of citrus owners. They propose to develop extra water for irrigation of their groves by, R. B. Bell, Dr. Charles H. Ford and others.

ILLUMINATION.

VICTORIA, B. C. The municipal council of Victoria has decided that it is necessary to extend and complete the system of lighting in the city of Victoria and that the sum of $50,000 required for the purpose be raised by bonding.

ELKO, NEV.—Sealed bids endorsed "Proposals for bids for furnishing and installing electric lighting fixtures for the new court house and jail, at Elko, Elko County, Nev.," according to plans and specifications of W. H. Weeks, architect, now on file in the clerk's office, at Elko, were received by Fred C. Voight, clerk of the Board of County Commissioners, up to July 12, 1911, when they were publicly opened and read. Result not announced.

SAN FRANCISCO, CAL. Sidney Sprout has returned from Siskiyou County, where he is superintending the engineering work on the new 35,000 kw. hydroelectric installation of the Siskiyou Light & Power Company. Three generating units will be installed. The power site is on the Klamath River near Thrall. In addition to tieing in with the company's existing power transmission lines from the Fall Creek power station the new lines will be extended to Klamath Falls where the company recently purchased a local electric plant.

TRANSMISSION.

SALINAS, CAL.- A surveying crew has commenced work staking out the pole line of the Monterey County Gas & Electric Company down the Salinas Valley.

OROFINO, ORE.- Announcement has been made that an extensive power plant will be built on the North Fork of Orofino creek at the mouth of Whisky Creek.

PHOENIX, ARIZ. The City Council has granted a franchise to the United States Reclamation Service to construct a power line through the corporate limits of Tempe. Irving C. Harris of Mesa represents the government.

PORTLAND, ORE. Permission is sought by the Portland Railway, Light & Power Company, of the War Department, to construct a high tension electric power line across the Willamette River from the foot of Linn avenue, Sellwood, to a point south of Riverview Cemetery.

FALLON, NEV.—The U. S. Government is arranging to build a big electric plant at the new Lahonton dam for the purpose of supplying power for the operation of the gates and dams of the big Truckee-Carson project and also for the operation of big electrical pumps to drain the Carson Lake. The people of Fallon have circulated a petition to the government to have this work done at once and to sell power to the city of Fallon.

SAN BERNARDINO, CAL. F. A. Worthley of Riverside will apply to the City Council for a franchise for an electric pole line covering this city. This is the initial move of the California-Nevada Power Company to get in Southern Cali-

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JOURNAL OF ELECTRICITY
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Devoted to the Conversion, Transmission and Distribution of Energy

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TRAIN DESPATCHING ON THE NORTHERN ELECTRIC

BY [illegible] H. BALDWIN

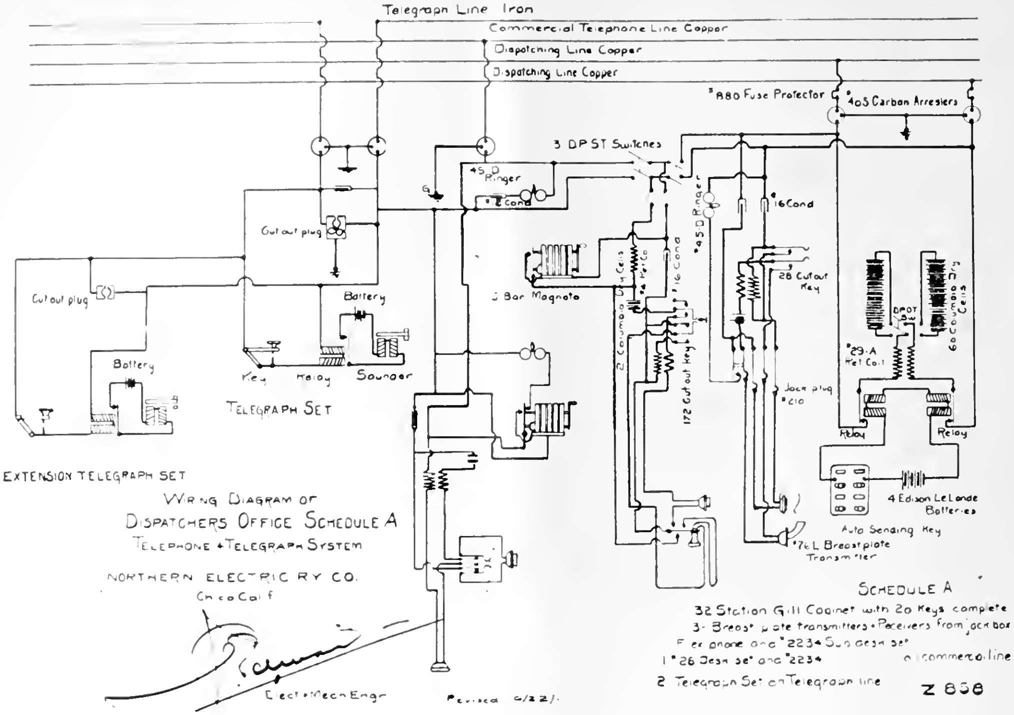
Another step in the advancement of electrical appliances in the operation of railroads, and one of special interest to those using electricity as a motive power has just been demonstrated with the completion of the telephone despatching system for the handling of trains on the Northern Electric Railroad in California.

[illegible]

This railroad operates between Sa[illegible] and Oroville in the central part of the State. Its trackage covers approximately one hundred miles of roadbed and is operated by the third rail system employing six hundred volts d.c. supplied through substations distributed at intervals along the right of way. The primary current supplying these substations ranges from twenty-two hundred to sixty thousand volts a.c. These high tension lines parallel the railroad for miles in many instances. It is the fact of operating successfully a telephone system with induction interference either from these high tension lines or the electric third rail that makes its success of special interest.

It was through the careful study of these conditions and the untiring efforts of Mr. J. P. Edwards, [illegible] the entire [illegible]

These [illegible] has been provided a despatcher [illegible] trains



Despatcher's Wiring Diagram of Northern Electric Company

a straight magneto telephone circuit for commercial work, and a Morse telegraph circuit for emergency work.

The telegraph instruments are looped from one side of the commercial circuit, a one microforad condenser being bridged across the loop at each station

J. P. EDWARDS, Electrical and Mechanical Engineer in Charge

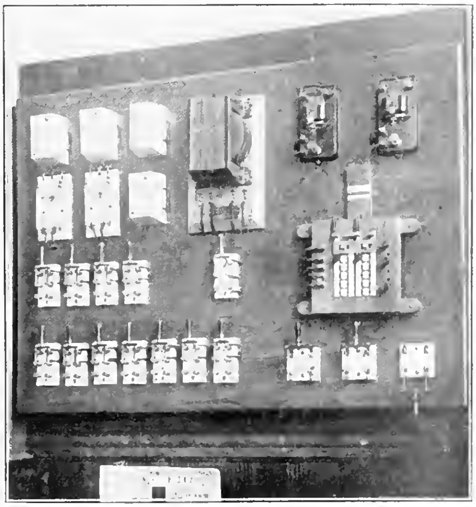
so that the telephone voice currents or the a.c. calling currents are not interfered with. The telegraph batteries are fed from each end of the line, and when not in use are cut off by means of switches. As these batteries are of the closed circuit gravity type it was necessary to provide a means of keeping the batteries working when not in use. This is accomplished by so arranging a switch that it will automatically close the battery circuit through a lamp resistance as soon as the switch opening the batteries from the line is operated. When not in use the telegraph relays are shorted out of the line circuit through a regular plug type telegraph switchboard provided at each station.

Despatcher at Desk

The commercial circuit is of standard magneto construction, using sixteen hundred ohm ringers and five bar a.c. generators. The instruments, however, are specially wired and equipped so that the way-station operators, by the use of a double pole, double throw switch, can use the same telephone on either commercial or despatcher's line.

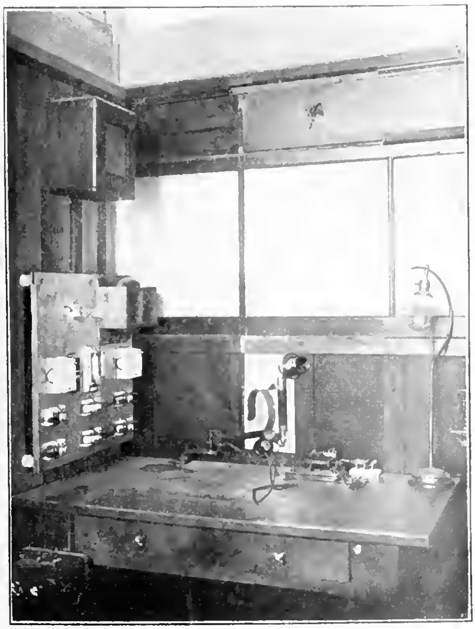
The despatcher's circuit is a metallic line of two hundred and ten pound copper, and no ground connections are necessary for its operation. The Kellogg Switchboard & Supply Company's standard railway telephone apparatus is used in connection with the

Gill main line selector. An automatic calling key cabinet is provided at the despatcher's desk, this cabinet being equipped with a separate key for each selector on the line. Each key has a given number,



Detailed View Despatcher's Switchboard

and a designation strip is also placed over each row of keys to indicate the names of the various stations. The selector bell of the station desired is rung by



Sacramento Way Station showing Switches and Simplex Coils

the sending of the proper combination of d.c. current impulses over the line. This is accomplished by turning the automatic sending key which operates a train of gears similar to the familiar district messenger call box, and this in turn operates a pony relay which feeds the selector battery direct to the line. All the selectors receive these d.c. impulses, but only the selector set to the correct combination of impulses rings its bell. The despatcher is supposed to be on the line at all times ready to receive communications from any station without being signalled. If for any reason he should leave his desk, by removing his telephone set plug from the jack a bell is automatically cut across the line. If a way-station operator fails to find the despatcher when he calls on the line, by a slight turn of the hand generator this bell can be rung.

The telephone instruments at the way-stations are equipped with condensers and so wired that they can be used on either commercial or despatcher's line, without interfering in any way with the various calls which might be going over the lines. Each way-station set, as well as the despatcher's instrument, is provided with a cut-out button. This button is so wired in the telephone circuit that when in the normal position the receiving efficiency in greatly increased, and when operated the outgoing transmission is likewise increased.

Field Telephone Box

Instead of equipping all trains with portable sets, all sidings and way stations where regular offices are not maintained have been provided with siding boxes containing a telephone set equipped to operate on either commercial or despatcher's line. These sets are provided with a double pole double throw switch so that the instrument can be used on either line as desired. The boxes are locked with station railway locks, and a switch key will let anyone authorized to use the instruments have access to same.

The line is divided into six divisions, and by the placing of knife switches at these division points patching stations have been established. By the operation of these station switches, under the direction of the despatcher, that portion of any line in trouble can be patched around by using the line wires of the commercial circuit until same can be put in order by the troubleman.

The entire system was manufactured and installed under the direction of the Kellogg Switchboard & Supply Company, who, with the aid of the engineering force of the Northern Electric Company, have marked another step in the advancement of this latest means of transmission in the handling of trains, which is being so generally adopted by the railroads to replace the telegraph.

NEW METHOD OF WATER MEASUREMENT BY USE OF ELBOWS IN PIPE LINE.

BY GASKELL S. JACOBS AND FRANCIS A. SOOY.

This article deals with the experimental determination of a new method of water measurements in pipes. A formula is deduced whereby the velocity flowing in pipes can be determined by simply boring taps at the inner and outer edges of an elbow in the pipe line itself and by reading the difference in elevation of the water columns of the inner tap and outer tap the velocity of the water may be computed after

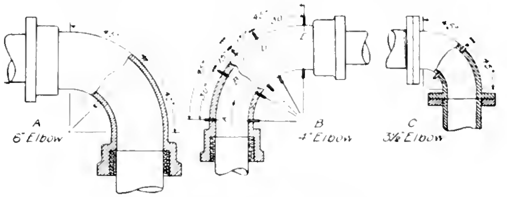


Fig. 1. Location of Taps for Three Sizes of Elbow

measuring the radius of the bend and diameter of the elbow. It is experimentally established that

$$v = 5.60 \sqrt[1.9]{h\frac{r}{d}}$$

Throughout this discussion the following notation is used:

v = velocity in feet per second.
r = mean radius of bend (in feet).
d = internal diameter of elbow (in feet).
h = difference in height of outer and inner water columns (in feet).
Q = discharge (in second feet).
n = an exponent.
A, B, C, numerical constants.

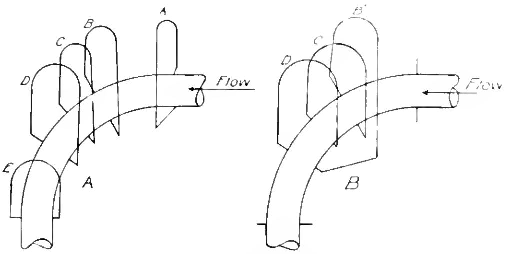


Fig. 2. Variations of Tap Distances in Elbows

Of the present methods of measuring the discharge of a pipe line, the Pitot Tube and the Venturi Meter are the most common. The former has the objection that skill and time and the use of a delicately constructed instrument are required to arrive at a satisfactory measure of flow, while the latter requires an expensive installation and results in a considerable loss of head in the throat piece. With these facts in mind it was suggested to the authors to investigate the possibilities of the use of a ninety degree elbow with properly placed taps as a measuring device on a pipe line. It had been observed and may also be shown from analytical considerations that there is a difference in pressure between the concave and convex side of an elbow. This fact formed the basis of the investigation.

The purpose of this paper is, in presenting the results of a series of tests on elbows, to show that there exists a consistent relation between the flow of water through an elbow and the difference in head between the convex and concave sides of the bend, also to show the possibilities of the use of an elbow as a measuring device.

The general problem was to determine the difference in pressure between the convex and the concave sides of the bend for a series of velocities in the elbows, and for as many elbows as were available.

The elbows used in this work are such as may be found on ordinary water mains, namely, 4 in. and 6 in. cast iron elbows with bell joints, and a 3½ in. flanged cast iron elbow. In their selection, we took care that the interior surface was reasonably smooth, which we examined by means of the insertion of an incandescent lamp. We also took care that there was no very large variation in cross section, and where necessary to secure this condition, any projection on the interior surface was chipped. The elbows were then carefully calipered for interior diameters in both horizontal and vertical planes and at a number of sections along the curves. These measurements were well within one-half of one per cent of the correct values. The mean diameter was taken as the average of all the calipered diameters and the area of cross section was assumed to be that of a circle, having this mean diameter.

The mean radius of the elbow was found by fitting cardboard templets to the concave and convex sides of the elbows, thus determining the inner and outer radius respectively, and the mean of these was taken as the radius of the bend. These radii are known to within five one-hundredths of an inch.

DETAILS OF THE 6 IN. BELL ELBOW.

Description—Standard Cast Iron 90 degrees, 6 in. Bell Elbow.
Taps—1 pair (at middle of bend).
Radius of Bend—

Outer ....12.40 inches
Inner .... 5.45 inches
Mean .... 5.92 inches
Mean Radius of Bend .... 0.743 feet

Diameter (internal).

Horizontal (inches)		Vertical (inches)	
6.10	6.15	6.15	6.00
6.15	6.15	6.05	6.00
6.15	6.17	6.00	5.98
6.13	6.14	6.00	6.00
6.15	6.10	5.96	6.05

Average Diameter—6.07 inches.
Average Diameter—0.506 feet.

Area of Section—
Area of circular section..............0.506 ft. in diameter
0.201 sq. ft.

Ratio Radius to Diameter—
$\frac{r}{d}$ 1.47

DETAILS OF THE 4 IN. BELL ELBOW.

Description—Standard cast iron 90 degrees, 4 in. Bell Elbow.
Taps—5 pairs (see sketch, Fig. 2).
Radius of Bend—

Outer ....12.60 inches
Inner .... 7.20 inches
Mean .... 9.90 inches
Mean Radius of Bend .... 0.825 feet

Diameter (Internal).

Horizontal (inches)	Vertical (inches)
3.87	3.90
3.80	3.80
3.80	3.80
385	4.00
3.80	3.90

Average Diameter..................3.84 inches
0.320 feet

Area of Section—
Area of circular section of diameter.......... 0.320 feet
0.0804 sq. ft.

Ratio Radius to Diameter—
$\frac{r}{d}$ 2.48

DETAILS OF THE 3½ IN. ELBOW.

Description—Standard Cast Iron 90 deg. 3½ in. Flanged Elbow.
Taps—1 pair (at middle of bend)

Radius of Bend—	
Outer	7.20 inches
Inner	2.50 inches
Mean	4.85 inches
Mean Radius of Bend	0.404 feet
Diameter (Internal)—	
Average Diameter	3.44 inches 0.287 feet
Area of Section—	
Area of circular section	0.287 feet diameter 0.0645 square feet
Ratio Radius to Diameter—	
$\frac{r}{d}$	1.41

The pressure taps were placed radially in the concave and convex sides of the elbow at the middle of the curve, and in a horizontal plane which we assumed to coincide with the break of the molds. These openings were carefully drilled (No. 19 drill used), then tapped and fitted with a threaded brass tube to which the gage tubes were attached. On the inside of the elbow a file was used to remove any projection about the opening, so as to leave it perfectly even with the interior wall of the elbow. The location of these taps for each elbow is indicated by sketches as shown in A, B and C, Fig. 1, which also show the elbows in detail. Note that in the four-inch elbow five pairs of taps were drilled to obtain an estimate of how the difference in pressures varied along the curves.

The gage consisted of an inverted glass U-tube of about 3/16 in. interior diameter suspended vertically above and connected by rubber tubing to the brass taps on the elbow. The difference in the water levels of the two sides of the gage gave directly the difference in pressure between the convex and concave sides of the elbow.

All the elbows were tested in a horizontal position. The approach consisted of a flaring intake from a bulkhead and three two-foot lengths of galvanized iron pipe of the same diameter as the inside of the elbow. The joint with the elbow was tightly caulked with a packing of cotton waste and a mixture of resin and paraffine applied hot. The discharge was a single two-foot length of galvanized iron pipe similarly joined to the elbow. In all the tests the approach, and elbow, and discharge were submerged so as to be sure that the elbow was running full of water. The approach and discharge were aligned with their respective tangents, and the arrangement firmly fastended to maintain the alignment throughout the test.

The flow through the elbow was maintained by an impeller pump, direct connected to a single-phase motor, and was measured by standard 2¾ inch circular orifices discharging under a constant head of 6 inches above their centers. The flow was varied by using a greater or a less number of orifices at a time, there being fourteen available. The orifices were all in the same vertical plane 6 inches to center. The entire equipment, elbow, discharge, intake, orifices and pumps were contained in a circulating tank which is shown in Fig. 3.

The head on the orifices was kept constant at 6 inches above their centers by the use of a multiple spillway (see sketch) in the forebay, having about 200 lineal feet of spillway length. The orifices were then carefully calibrated, and when not in use were kept greased to prevent rusting or change. Calibration was performed by measuring the flow for a known interval of time in a tank of known dimensions. A number of the orifices were thus calibrated alone and

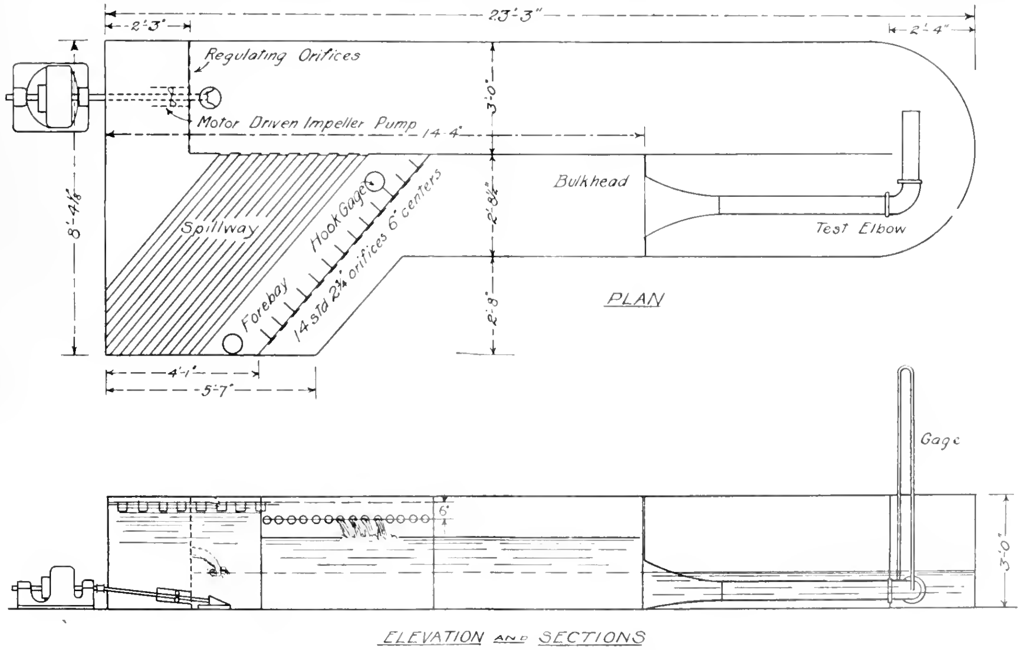


Fig. 3. Detail of Hydraulic Control for Tests

the average discharge for each one was found to be 0.142 second feet very closely, with the constant head of 6 in. above the center of the orifice. In order to determine whether the flow from any one orifice was affected by the flow from an adjacent one, they were re-calibrated under these conditions, but there was no appreciable difference. As a further precaution against interference of flow, permanent wing partitions had been placed between the orifices, extending back into the fore-bay. For the calibration data see Table I.

TABLE I.
CALIBRATION OF ORIFICES.
Dimensions of Calibration Tank 34½ x 36¼.

Orifice Number	Time (Seconds)	Rise (Inches)	Discharge (sec. ft.)
7	70	13.62	0.141
6	65	12.69	0.141
5	60	11.91	0.143
4	60	11.81	0.142
3	60	11.81	0.142

Average discharge for one orifice (cu. ft. per sec.) 0.142

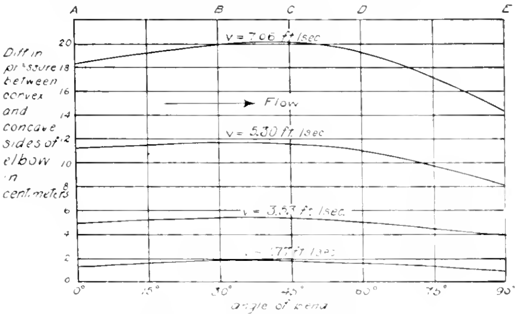


Fig. 4. Pressures at Different Points in Elbow Bend.

The first set of readings were taken on the 6 in. elbow, over a range of velocities from 0.7 to 7.0 linear feet per second in the elbow and the readings of the gage for each of these gave at once the difference in head between the convex and concave sides of the bend. When the flow in the elbow became constant there was very little vibration of the water columns in the gage, so that close readings were possible, only a slight tapping being necessary to insure the stability of the water columns. The zero reading of the gage was checked from time to time during the test. Plotting the results on logarithmic cross section paper as in Fig. 5, shows conclusively that the difference in head varies very closely to the 1.9 power of the velocity. This convinced us that for any particular elbow the variation was at least consistent.

With a tapered intake, a considerable length of approach, and a smooth joint at the elbow, we felt sure that the water reached the curve in a state of normal flow, i. e., the distribution of velocities in the approach was very closely that of a long straight pipe with no obstructions. In order to determine whether an obstruction in the approach a short distance from the elbow affected the reading of the gage due to the resulting disturbance in water in the approach, a brick was placed across the intake so as to direct the water into the approach in a divided stream, which later joined in the pipe. Such conditions as these are common in water mains, there being all sorts of disturbances due to the presence of gates, tees and deposits in the pipe. The observations taken with the obstructions showed that little or no change was produced due to this cause. We thus satisfied ourselves that the condition of the advancing stream caused by disturbance say 10 diameters above the elbow is of little moment as regards the difference of heads between the convex and concave sides of the elbow. See data sheet for 6 inch elbow tests, Table II.

TABLE II.
TESTS ON 6 IN. ELBOW.

Orifices.	Q (sec. ft.)	Vel. in elbow (ft. sec.)	Diff. in Head (cm)	Diff. in Head (ft)	Remarks
1	0.142	.71	0.4	.0131	Head on orifices 0.5
2	0.284	1.41	1.3	.0430	
3	0,426	2.12	3.2	.1025	
4	0.568	2.83	5.5	.180	Jan. 27, '09, normal flow discharge completely covered Gage O. K.
5	0.710	3.54	8.7	.286	
6	0.852	4.25	12.4	.410	
7	0.994	4.96	16.8	.555	
8	1.036	5.66	21.2	.697	
9	1.278	6.36	26.0	.850	
10	1.420	7.07	30.9	1.013	
6	0.852	4.25	12.0	.395	
5	0.710	3.54	9.2	.302	
4	0.568	2.83	6.4	.219	Normal flow.
3	0.426	2.12	3.5	.114	
2	0.284	1.41	1.8	.0590	Discharge covered.
1	0.142	.71	0.5	.0164	(7-10 out rejected as discharge not covered).
1	0.142	.71	0.4	.0131	
2	0.284	1.41	1.4	.0460	Jan. 23, '09, O. K. all.
3	.426	2.12	3.0	.099	
4	.568	2.83	5.3	.174	
5	.710	3.54	8.5	.277	
6	.852	4.25	12.1	.397	
7	.994	4.96	16.4	.540	
8	1.036	5.66	21.4	.700	
9	1.278	6.36	26.1	.851	
1	0.142	.71	0.55	.0180	
2	0.284	1.41	1.5	.0490	Jan. 29, 09.
3	.426	2.12	3.25	.107	
4	.568	2.83	5.7	.186	Intake obstructed with brick. Discharge obstructed with bricks.
5	.710	3.54	9.0	.295	
6	.852	4.25	12.5	.411	
7	.994	4.96	16.8	.555	
8	1.036	5.66	20.9	.685	

The next set of tests on the 4 in. elbow was performed to check up the relations found in the 6 in. elbow and also to investigate the variation in the difference of pressures for various points along the bend. Plotting the results of the run on the 4 in. elbow confirms the variation in head with the 1.9 power of the velocity as found in the 6 in. elbow.

To investigate the pressures along the bend between the convex and concave sides, five pairs of radial taps were placed as follows:

Taps A—at entrance tangent.
Taps B—30 deg. from entrance.
Taps C—45 deg. from entrance (at middle of bend)
Taps D—60 deg. from entrance.
Taps E—at discharge tangent.
See B, Fig. 4.

Simultaneous readings of all five gages were taken for various velocities as tabulated in Table III, and the curves, Fig. 4, were plotted showing as abscissae the center line of the elbow developed and as ordinates the gage readings, for various velocities through the elbow. These curves show that the maximum difference in pressures occurs at the middle of the bend and for sections near the middle it is very nearly the same. Note also that the difference in pressures at the discharge tangent is less than that at entrance tangent, due, perhaps, to the greatly disturbed condition of the water when it reaches the end of the curve.

As mentioned above, the difference in pressures for sections near the middle are very nearly the same, the pressures being measured for taps radially opposite. It was thought that in practice, the pair of taps might not be placed radially opposite, and the ques-

tion arose whether this would give different readings of the gage than for radially opposite taps. The gages were re-arranged as shown in B, Fig. 2. The angular displacement of taps from radial opposition is 15 degrees for taps C and D, and 30 degrees for B, A and E remaining the same. In using the middle pair of taps a displacement of 15 degrees would be quite improbable in practice. The readings of all the gages are tabulated in Set No. 2, Table III, and show in no case a greater variation than 2 per cent from the corresponding gages correctly placed even with the displacement 15 degrees. With small displacements, as might occur in practice the error would certainly be negligible.

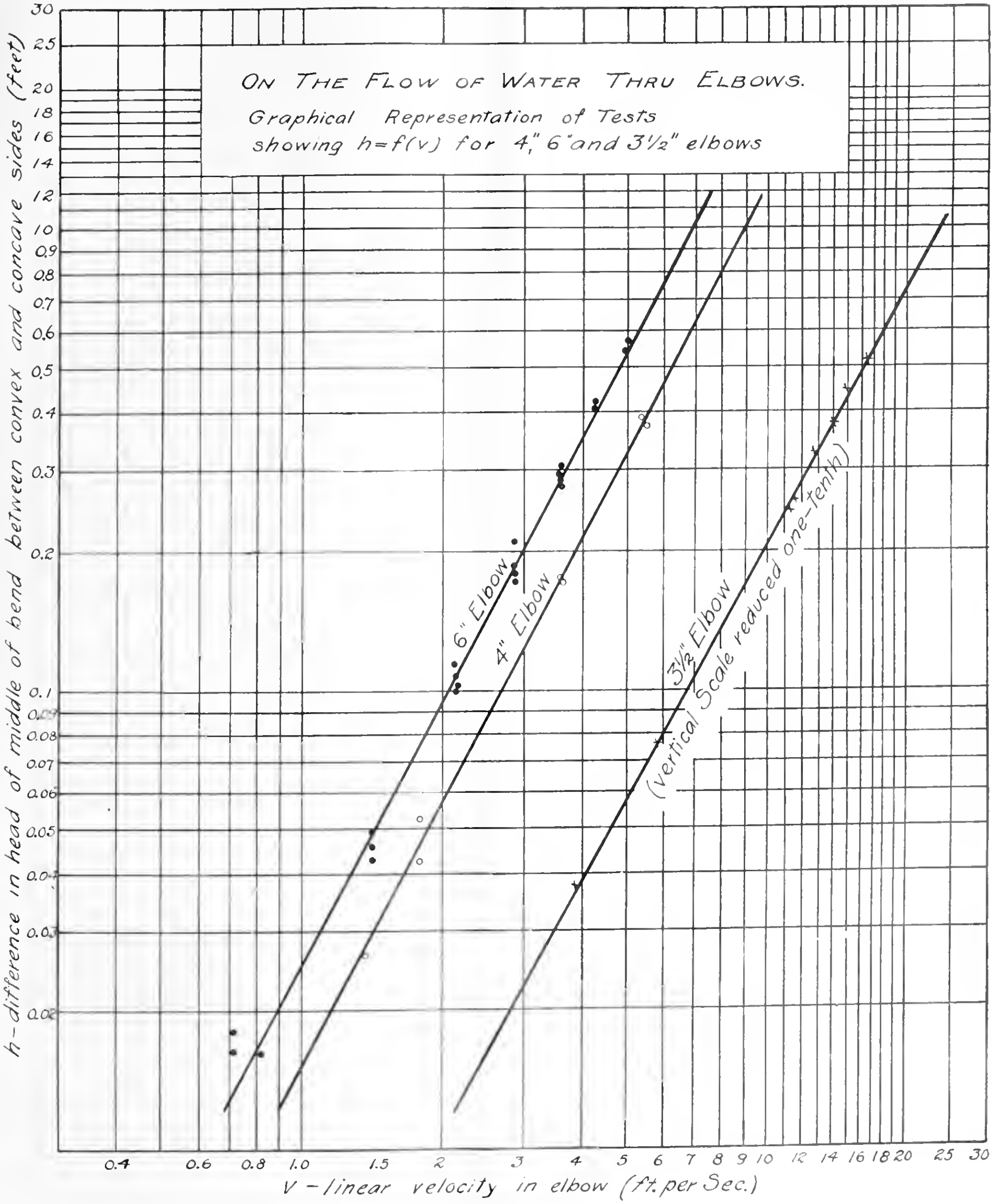


Fig. 5. Logarithmic Plots of Velocity.

The question of the condition of the approach to the elbow and its effect on the difference in pressures was very clearly shown in the test on a 3½ in. flanged elbow. In this test the flow was measured over a 2.5 foot rectangular fully contracted weir in the Hydraulic Laboratory of the University of California.

TABLE III.
TESTS ON 4-IN. ELBOW.

Feb. 9-12, 1909.

See A, Fig. 1, for position of gages as designated below.

SET NO. 1.

Number of Orifices.	Gage Readings (C M) A	B	C	D	E	Remarks.
4	16.1	17.8	18.8	18.3	13.7	Discharge barely covered.
4	16.3	17.9	18.9	18.3	14.0	
4	16.1	17.4	18.4	17.5	13.5	
3	10.6	11.4	12.2	11.5	9.0	
3	10.4	10.8	11.8	10.9	8.5	Discharge covered.
3	10.3	10.7	11.5	10.9	8.2	
2	4.7	4.85	5.27	4.95	3.90	
2	4.4	4.85	5.20	4.90	3.85	
1	1.37	1.25	1.25	1.23	1.04	Bulkhead leaking slightly.
1	1.33	1.22	1.31	1.24	1.03	
1	1.34	1.21	1.29	1.23	1.00	

SET NO. 2.
MAL ARRANGEMENT OF TAPS.
See B, Fig. 2.

Number of Orifices.	Gage Readings (C M) A	B′	C′	D′	E	Remarks.
4	16.8	17.4	18.8	18.1	14.9	Discharge barely covered.
4	16.9	17.5	19.3	17.9	13.4	
4	17.3	17.9	19.4	18.3	14.0	
3	10.3	10.7	11.7	10.9	8.5	
3	10.3	10.5	11.5	10.8	8.4	Bulkhead tight.
3	10.1	10.5	11.4	10.8	8.2	

RESUME OF TESTS ON 4 IN. ELBOW.

Number of Orifices	Discharge (sec. ft.)	Velocity (ft. sec)	Gage Height CM	Ft.
1	0.142	1.77	1.29	.0424
2	0.284	3.53	5.23	.172
3	0.426	5.30	11.8	.388
4	0.568	7.06	18.7	.614

TABLE IV.
TEST ON 3½ IN. ELBOW.

February 19, 1909.

Weir head ft.	Actual Discharge sec. ft.	Vel. in Elbow ft. sec.	Gage Reading Inches	Feet
.079	0.194	3.01	2.68	.223
.097	0.250	3.83	4.5	.375
.125	0.380	5.89	9.3	.775
.126	0.385	5.97	9.5	.791
.163	0.556	8.63	19.0	1.582
.167	0.580	8.99	19.8	1.649
.163	0.580	8.99	19.8	1.649
.193	0.718	11.14	29.4	2.45
.196	0.734	11.39	31.0	2.58
.197	0.734	11.39	31.6	2.63
.210	0.812	12.60	39.4	3.28
.224	0.890	13.81	46.3	3.86
.227	0.910	14.11	47.0	3.92
.227	0.910	14.11	48.0	4.00
.237	0.965	14.96	54.	4.50
.238	0.972	15.07	54.9	4.57
.248	1.036	16.06	62.0	5.17

Note: Width of Weir on crest, 2.5 feet

The elbow was placed in a horizontal position in the bottom of the weir box, and the flow maintained by a centrifugal pump. The approach consisted of a long horizontal discharge line from the pump—a 4 in. 90 degree elbow, then a 5 ft. vertical length of 4 in. casing, then a 3½ in. elbow, then a 3 foot horizontal run of 4 in. casing, so that the water made two right-angle turns before reaching the test elbow. The test elbow bolted through its flanges to the approach with a rubber ring gasket between flanges and the discharge was a similarly joined 2 ft. length of 4 in. casing. A single pair of taps at the middle of the bend was used. A variation of velocities of from three to sixteen linear feet per second through the elbow was obtained, the latter being higher than would ordinarily occur in practice. Due to the pulsatory nature of the flow at high velocities, considerable vibration of the gage levels was encountered, but by noting the swing and taking the mean, consistent readings were obtained as is shown in the curve, Fig. 5, plotted from the results in Table IV. The approach in this case was such as to produce considerable disturbance in the flow toward the elbow, yet the results were not appreciably affected. This further substantiates the fact that normal flow is regained in a length of ten diameters. In this case as in the 4 in. and 6 in. elbows, the variation in head adheres to the 1.9 power in velocity.

Having completed the experimental work it was next necessary to develop the relations found in the experiments in the shape of a formula which would summarize closely the entire set of tests, and which would be of practical application. From the logarithmic curves plotted in Fig. 5 there can be no doubt but that the relation

$$h = A(v)^{1.9}$$

holds for each elbow, for the tangent of the angle that each line makes with the horizontal is very close to 1.9, which logarithmic cross section paper corresponds to above equation. It will be noticed that points corresponding to low velocities do not lie as close to the curve as those for higher velocities, this being due of course to the greater percentage error in reading small differences in head.

The next step was to deduce an expression involving the various constants of the elbow in the general constant A in the equation $h = A(v)^{1.9}$. From the centrifugal nature of the flow, it is natural to suppose that the pressure difference, which is analagous to centrifugal force, varies inversely as the radius of the curve. Since the difference in pressures depends on difference in radial distance from the center, of the points at which the effects are measured, it is probable that the difference in pressure heads varies with the diameter. Therefore the constant A may be recast into the form $B\frac{d}{r}$ and in its most general form the formula becomes $h = B\frac{d}{r}v^{1.9}$

However, in practice, v is the dependent variable and hence its more useful form would be.

$$v = 5.60\sqrt[1.9]{h\frac{r}{d}}$$

for this gives the required velocity in terms of the measured quantities and a coefficient which we shall now evaluate. Substituting values for v, h, r, and d for a number of cases for each elbow we have

For 6″ elbow C = 5.58.
For 4″ elbow C = 5.61.
For 3½″ elbow C = 5.74.

The value of 5.74 for the 3½ inch elbow differs by about 2½ per cent from the mean of the other two, but it will be remembered that the flow in this test was measured over a weir whose accuracy is questionable to within this figure at least. The gage on the elbow and the hook gage measuring the weir head were read simultaneously, but on account of their distance apart of 10 feet, and on account of the size of the weir box, it is probable that inequalities in flow observed on the elbow gage caused by the speed variation of the pump were not indicated at the same time on the weir gage, thereby introducing further slight errors. Hence the authors feel safe in saying that for small elbows C = 5.60 very closely and the formula holds to within 2 per cent, making due allowance for the accuracy of all methods employed in arriving at this result.

The accuracy of this final result depends on the accuracy of the methods used in determining each of the quantities which enter into it. These we estimate as follows, taking as the error of any set of measurements, the difference between the mean of a set and the measurement of maximum variation

d is measured to within 1/2 of 1 per cent.
v is measured to within 1 per cent.
h is measured to within 2 per cent.
v is measured to within 4/10 of 1 per cent.

The combination of these according to the above formula gives the accuracy of the combined measurements within 1.8 per cent, or say 2 per cent at the most.

In order to facilitate the use of the above formula the chart, Fig. 6, has been prepared, giving the

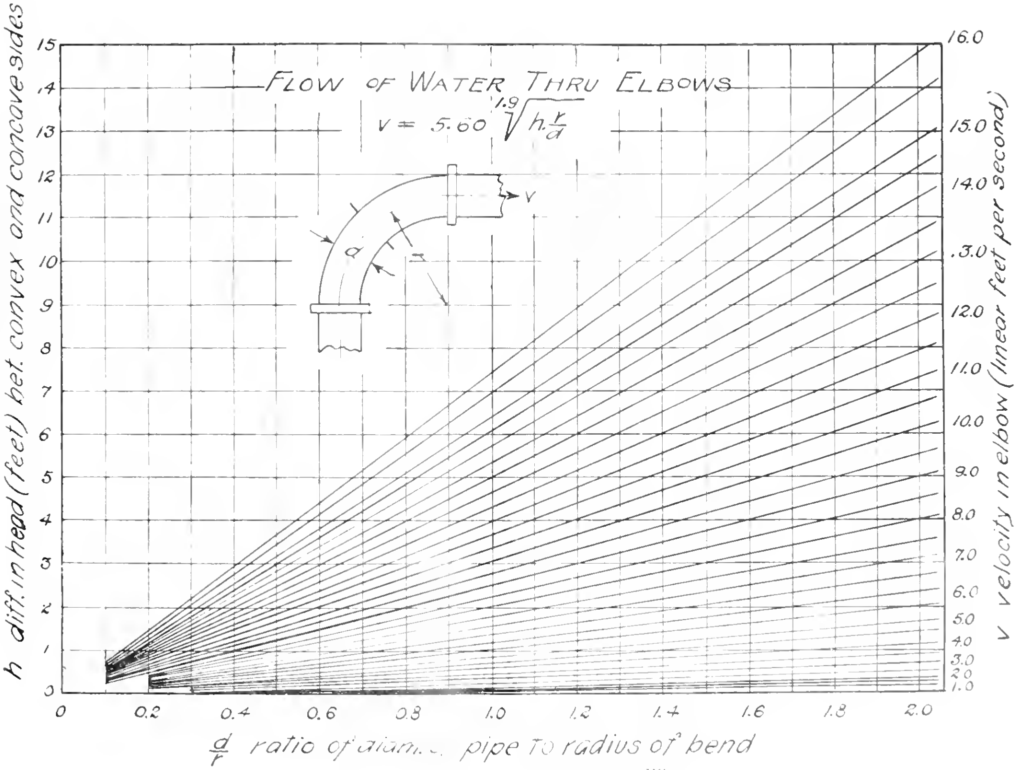


Fig. 6. Velocity in Pipe for Any Given Elbow

value of "v" for any pair of values of h and $\frac{d}{r}$

Conclusions.

1. There is a consistent relation between the flow of water in an elbow and the difference in pressures between the convex and concave sides at the middle of the bend.

2. The relation as given in formula holds to within 2 per cent for small elbows and probably holds for all sizes with slight modification.

3. Disturbed water in pipe line returns to normal flow after a distance of 10 diameters below the disturbance.

4. The position of the taps should be radial and exactly opposite at the middle of the bend and in a horizontal plane, but small departures from any or all of these conditions but slightly affects the results. If the elbow is placed in any other than a horizontal position the gage reading must be corrected for the static head corresponding to the vertical distance between the taps.

5. The ordinary 90 degree elbow is a satisfactory measuring device, and for those tested above is as accurate as any method employed at present.

6. The adoption of the elbows as a measuring device has the following advantages:

(a) It is applicable to pipe lines in place, for almost every line has an accessible elbow.

(b) Position of elbow with reference to gates and tees, if the latter are more than ten diameters ahead of elbow, is of no consequence.

(c) Simplicity of apparatus.

(d) Quickness and ease with which the necessary reading is obtainable.

7. With a suitable device for measuring very small differences in head such as a differential gage, the method outlined provides a simple positive determination of small flows such as due to leaks in a pipe line.

8. As a permanent measuring device, the use of a cast-iron elbow with a finished interior surface, say enameled, with permanent pressure taps and re-

cording device is advised. If calibrated, its readings could be depended on to a greater degree of precision than those of some present forms of meters.

The authors regret that lack of time has prevented the further investigation of this problem and its extension to other sizes of elbows. As far as is known, this is the first work in this direction performed to date, and if the results presented here will only tend to stimulate further investigation, the purpose of this paper will have been accomplished.

We desire to express our sincere appreciation and thanks to Mr. Buckner Speed, M. S., of Berkeley, under whose guidance and in whose laboratory the greater part of this work was performed.

We also wish to express our thanks to the People's Water Company of Oakland, through their engineer, Mr. Marks, who kindly furnished the 4 in. and 6 in. C. I elbows, and also the Professors Le Conte and Etcheverry of the University of California for their kindly hints and suggestions.

NORTHWEST ELECTRIC LIGHT AND POWER ASSOCIATION CONVENTION.

Convenes Thursday, September 21, 1911, at Spokane, Wash. Papers to be presented include:

1. "Problems of Power Transmission and Distribution."
   Editor, Mr. Fiskin, Washington Water Power Co.
   Associate Editors, Jno. Harrisburger, Sea. Tac. Power Co.
   H. R. Wakeman, Portland Ry., Light & Power Co.
   D. F. McGee, Pacific Light & Power Co.
   S. C. Lindsay, Seattle Electric Co.
2. "Central Stations Publicity and Commercial Policy."
   Editor, W. J. Grambs, Seattle Electric Co.
   Associate Editors, M. C. Osborne, Wash. Water Power Co. F. F. Barbour, Portland Ry., Light & Power Co. T. L. White (Byllesby & Co., Dalles, Ore.).
3. "New Business Methods for the Small Central Station."
   Editor, Arthur Gunn, Wenatchee, Wash.
   Associate Editors, M. D. Spencer, Eugene, Ore. L. B. Faulkner, Olympia, Wash. Fred Shields, Moscow, Idaho.
4. "Legal Aspects of the Light and Power Business."
   Editor, N. W. Brockett, Seattle-Tacoma Power Co.
   Associate Editors, F. T. Griffith, Portland Ry., Light & Power Co. Hugh A. Tait, Seattle Electric Co., F. T. Post, Washington Water Power Co. R. W. Wilbur, Portland Ry., Light and Power Co.
5. "Methods of Accounting in Connection with the National and State Legislature."
   Editor, C. N. Huggins, Portland Ry., Light & Power Co.
   Associate Editors, Wm. Best, Seattle, Tacoma Power Co. D. C. Coplas, Washington Water Power Co., Auditor or Treasurer Byllesby Co. A. W. Q. Birtwell, Seattle Electric Co.
6. "Central Station Problems."
   (a) "Line Extensions."
   (b) "Question of Meter or Flat Rates in Small Towns."
   Editor, A. C. McMicken, Portland Ry., Light & Power Co.
7. "Meter Accuracy in Relation to Central Stations Increase."
   Editor, R. E. Thatcher, Seattle Electric Co.
   Associate Editors, K. L. Willis, Portland Ry., Light & Power Co. T. G. Finley, Washington Water Power Co. Mr. Snyder, Seattle-Tacoma Power Co.
8. "Electric Heating and Kindred Uses of Electricity."
   Editor, F. F. Barbour, Portland Ry., Light & Power Co.
   T. C. Martin, secretary of the National Electric Street Association, will be in attendance.

METHODS OF CALCULATING ILLUMINATION.

Discussion before San Francisco Section, American Institute of Electrical Engineers, on paper presented by L. S. Twomey on June 23, 1911, and printed in these columns on July 1, 1911.

S. J. Lisberger (Chairman): We have listened to an interesting paper this evening on the subject of methods of calculating illumination. There is probably nothing more interesting to the engineer—or nothing that has been more neglected than the subject of illumination. I think some of our mathematical experts have told us that out of the total amount of energy put into the light we get something less than two per cent of its effective value. There are no doubt quite a few members present who would like to ask Mr. Twomey some questions. The paper will now be open to discussion.

C. L. Cory: I don't know that I have any particular question to ask. I, like many of the rest of you, have been especially interested this evening in listening to the theoretical process whereby these extremely practical tables have been evolved; and the author has shown us how very readily these tables may be adapted for any particular kind of illumination. As our chairman has said, I think perhaps a number of us have from time to time been more or less going by the rule of thumb, or groping in the dark, to obtain the result which has been shown here this evening as the proper illumination for some specific purpose; and the conditions in any one room or space to be illuminated differ so largely, that the results given us here may be practically applied, and I think are extremely interesting, and certainly valuable.

Again, it has been running through my mind as I have been listening to the paper and looking at the slides and the curves and the constants, that we are no longer, perhaps, from the purely electrical standpoint, dealing with a certain quantity of electrical energy in the light-giving device; in other words, if you care to consider the incandescent lamp, we have progressed from the ordinary single hair-pin light filament of the carbon lamp without any shade and without any particular concern being given to the shape of that single, hair-pin shaped filament, to a combination of things which, after all, is a lamp much more efficient than the ordinary carbon lamp was in the first place; a filament more complex in form, but at the same time capable of giving a more uniform distribution of light; then finally that combination supplemented by a reflector to place the light where it is most desired.

I was especially impressed with the last few slides, which showed how in the first place the light was more intense at an angle of some 40 degrees from the vertical, and the next slide where the light was almost a vertical tube with a flat bottom; and the last, where the distribution was practically parallel with a circle drawn through the center of illumination.

The paper has been extremely interesting, and I am glad to have been fortunate enough to have followed the development from the purely theoretical standpoint to the extremely practical results that the tables show.

H. Y. Hall: I would like to ask Mr. Twomey to give some method of calculating indirect illumination.

Mr. Twomey: I am very sorry, but I havent anything along that line. I really have dealt very little with indirect illumination and do not know much about it; but aside from that, from all the installations I have seen of indirect illumination, I doubt whether any calculations have been made.

Mr. Hall: Are there any constants that can be used?

Mr. Twomey: Mr. James R. Cravath in the Electrical World of May 11th, 1911, presents a very able article on this subject which seems to be about the only thing available at this time. Mr. Cravath gives a table of efficiency constants for indirect lighting which should be used in a manner

similar to those given in Fig. 13 of the paper under discussion. These constants applied for centrally located fixtures with efficient mirrored reflectors and clean glassware are as follows:

EFFICIENCY CONSTANTS FOR INDIRECT LIGHTING FROM CENTRALLY LOCATED FIXTURES WITH EFFICIENT MIRRORED REFLECTORS AND CLEAN GLASSWARE

Height Feet.	Room Dimensions Feet.	Color Walls.	Ceiling.	Per cent efficiency from lamp to working plane.
8.5	12 x 16.5	Lt. Green	Lt. Cream	[illegible]
9.8	15 x 15.2	Dark Green	Lt. Cream	28.0
9.8	12.7 x 12.7	Lt. Figures	Lt. Cream	37.0
14.5	57.6 x 70	Lt. Cream	Lt. Buff	36.0

It seems to be the opinion of many prominent engineers that in the future we may expect more development along the lines of semi-direct lighting. If we have an Alba reflector or a reflector of similar character inverted, the greater part of the light is thrown up to the ceiling, while a small proportion is transmitted directly through the translucent reflector. It takes away the peculiar cold effect that you may have noticed in direct lighting installations. It seems to be the opinion of quite a number of prominent engineers that this is coming into use.

H. W. Crozier: I would like to ask to what extent the eye strain is due to the varying color of the light. With a carbon light, which is mostly yellow, there is not very much eye strain, but with some tungsten lamps the strain is considerable, and it is noticeable when the change is made from the carbon to the tungsten. Is that due to the increased intensity or more to the color of the light?

Mr. Twomey: You are trying to change from carbon to tungsten?

Mr. Crozier: Yes.

Mr. Twomey: I think that you will find in most cases it is due to the poor installation of the tungsten units rather than to the color of the light. The intrinsic brilliancy of the tungsten filament is many times that of the carbon filament, so that in all cases where lamps are used within the line of vision or where the lamp itself may be seen at all, it should be frosted. For service such as in this room the lamps should always be bowl frosted and equipped with reflectors. As far as effect of the color on eye strain, that seems to be a question for the physiologist to determine.

A. H. Babcock: The question just asked suggests something that is made use of in the design of telescopes where optical work is required; that is, the function of the telescope is to gather as large an amount of light as possible, and draw it to the eye in such shape that it can be recognized—the point of light at a great distance can be recognized. Now it is impossible in the line of lenses to bring all of the spectrum to the same focal plane. Consequently it is the effort of those who design telescopic lenses to bring to the focus as much of the spectrum as the human eye responds to with the greatest activity. For that reason the great Lick telescope is designed to bring the yellow and green to the focus, the red, the lower end of the spectrum goes beyond in one direction, and the violet goes beyond the focal plane the other. One is inside and the other is outside. The effect of this is that when the spectroscope is attached to the telescope, and the tube is rotated in such a manner as to bring various parts of the spectrum to the eye, when you turn from one end of the spectrum to the other you turn slowly, so your eye is accustomed to the light it gets. When the yellow and green come in you almost instinctively close your eye, because there is such a great difference in the intensity. The question just asked suggested to my mind whether that color effect did not have much to do with the tiring effect on the eye. I realize quite fully that the direct light of a very brilliant source does tire the eye; but the fact that the human eye has for many centuries been adapting itself to a preponderance of yellow rays which we get out of the sunlight would indicate to me that the eye is best adapted to recognize the yellow and green rays. That is taken advantage of, as I say, in the construction of great telescopes, where the quantity of light and its effect on the eye are of the utmost importance.

The paper of the evening has been very interesting to all of us who have had to do with lighting and with illumination. I regret very much that this meeting is not attended by every architect within reach, because my experience has made me feel that architects above all others are the most ignorant on the subject of scientific illumination. I have had several times to clear up some lighting messes made by some rather important architects; and the utter disregard that is shown to common-sense methods in illumination is something astonishing to one who has not run into it. In one of our large draughting rooms in the general offices of the Southern Pacific Company the draughtsmen complained they were not getting light enough. There were 16-candlepower carbon lamps high up in the ceiling, so the architect in charge of the building simply doubled up his candlepower. Then the wiring was not adequate for the double load, and the voltage dropped off. It was only by the force of an order from the proper authority that the man was made to consider the use of a proper lamp, with a proper reflector back of it.

Now that man is not an ignorant man. One piece of work that he did you gentlemen saw at the last meeting; but when it came to lighting he was the most pig-headed man that I have had to do with. It is not confined to him. It is characteristic of the breed. They don't know; and they don't know that they don't know. It is a subject which is extremely irritating to a man who deals directly with precise methods, and I think that some of you lighting experts would do well to convert a few architects if possible to a more rational view of things.

Mr. Twomey: In some cases, Mr. Babcock, our efforts to convert the architects have met with about the same results as you mention.

Mr. Cory: There is nothing like getting a large number of opinions that we know are coming from very different sources. I would like to ask Mr. Vincent if he can give us any experience that he had about lighting a very large room from the ceiling I think about 100 feet from the floor?

W. G. Vincent: I don't know that I have anything special to say about that room, because it has not been used yet. I am waiting to see what the result is when it is used. But I have found this great difficulty, that the personal equation enters so much into the question of lighting. For instance, I like a general illumination. I don't like a light right in front of me reflecting on the table; but it seemed to be the idea of the architect in this case that each reading table should have a lamp right in front of it. I think the tiring effect that Mr. Babcock speaks of is due to the excessive light on the paper reflecting on the eye. Light on the paper sufficient for reading purposes would not have that tiring effect. I was trying to hold down to general illumination from above which would be sufficient, and not in excess to the eye.

I think the principal work of the illuminating engineer is to get the location of outlets properly spaced; because the conditions of usage of rooms vary so much that it is hard to say just the quantity of light to suit all conditions; and I think the principal thing in a building is to get the spacing properly laid out; after that is done it can be suited to the conditions of the room. Isn't that what you think, Mr. Twomey?

Mr. Twomey: Yes, I believe that is so.

Mr. Vincent: The conditions of the lighting and tinting of the rooms vary from time to time, and it seems impossible to figure out what the particular color is going to be; but the architect always has ideas about the artistic effect of the

spacing of the outlets, which do not agree with the engineering.

A Member: One of the speakers has mentioned the difficulty of having the architects take up the question from the engineer's point of view. I believe it is true that in many respects it is the fault of the electrical engineer that difficulties arise, and I believe that if there were some effort made to have the speakers of the different societies of the city speak on these subjects, it would remedy some of the conditions mentioned. I would suggest, therefore, that it be taken up with the executive committee, with a view to having some of our speakers address the American Institute of Architects, and some of them address us. No doubt we can learn something.

Mr. Babcock: I would like to ask the author what he considers to be a fair method for a contract between a municipality and the lighting company for street illumination: whether or not it is possible to make a contract on the basis of a certain minimum illumination so many foot-candles at any point along the street; and whether it would be possible to draw a contract in that way which would be fair to the municipality and to the lighting company, to specify the minimum illumination by foot-candles at any point of the street?

Mr. Twomey: The way that is generally done is to get up plans and specifications for the lighting, and not only specify candlepower, but specify the location and equipment and reflectors and so forth. When that is made out by competent engineers they secure the result desired that you speak of. This is simply another way of getting at it, although I have heard of them specifying a certain equipment and efficiency of units.

Mr. Lisberger: I think that could be done if the city had enough to pay for the lighting, or the lighting company could make a low enough rate to meet the city's financial condition. I think you would run into a number of difficulties in attempting this except on well-lighted streets. For example, take Market street, or Broadway in Oakland, where you can absolutely space lights at a given interval in case the city could afford to do that; but if you take scattered territories I don't think you could do it, particularly when you take into account tree conditions, where it would be absolutely impossible to live up to them, even with any type of lighting you might put in.

I don't know whether I caught your point or not.

Mr. Babcock: No, I don't think the Chairman does quite cover the point. Of course if the streets are entirely covered with trees so they arch over the roadway it is a very serious difficulty, especially if the trees should be low. But suppose you had a case, for example, as we have sometimes now, where a municipality, in granting a railway franchise, calls for the street to be illuminated. The railroad company, in part consideration of its franchise, agrees to light its streets. There is a practical question. As some of you know, there is a tendency here in this district nowadays to insert such a provision. The question immediately arises, What kind of light? My contention is, it is none of the municipality's business what kind of light is put there. What they are after is a certain illumination of the street. That is the practical thing that we are after. The question is, as far as the railroad is concerned, how far ahead of a moving train can a man or wagon be noticed by the motorman; and that, to me, is the practical point involved in this case.

Now over in Oakland the City Council has demanded this point in some of our franchises. Questions may arise, What kind of light? I deny, as I said before, it is any of the business of the municipality. It was our business to ask for a definite specification as to the quantity of light at any given point. In one case there was a city electrician who was amenable to reason. There was a provision of that kind put in the franchise, that a minimum illumination of .01 foot-candle should be furnished by the railroad, the choice of the apparatus to lie entirely in the railroad company's hand, but the design of the fixtures to be approved by the Board of Public Works. Under that franchise there has been no lighting done so far; but I have no doubt it can be worked out. There is also in that franchise a method for determining the illumination at any point along the street, the provision being to calculate from the manufacturer's certified curve of the lamp used what the illumination will be.

The point I had in mind was to find out whether any other contract of that kind was known, and if so, how it worked out, and whether the author thought it was practical to work such a thing to a conclusion.

Mr. Twomey: In the case of low units and improper reflectors with excessive glare, although the foot-candle intensity may be high enough at any point the glare might be so great that there would be a great deal of difficulty in distinguishing objects far ahead of the train, especially objects on the other side of light source. When you have low units of great brilliancy in a poor installation, the foot-candle intensity might be decreased and by installing a properly designed system better results would be secured.

Mr. Babcock: Wouldn't it be the tendency of the engineer of the railroad company to give as low an intensity as he could? It seems to me it would be my business in that case to get as much illumination from the source of light as possible; and in this particular case we had to consider incandescent lamps for that reason, which would produce the .01 candles.

Mr. Twomey: That is apparently ample illumination as far as the elimination of danger from moving trains is concerned.

Mr. Babcock: How would that compare with the ordinary street illumination?

Mr. Twomey: A minimum of .01 foot-candles compares very favorably except with the lighting in business districts; there it runs as high as 0.10 foot-candles in some cases. The minimum illumination specified frequently for residence districts is .004 foot-candles.

Question: Isn't it a fact that most of the methods used in the streets are very inefficient.

Mr. Twomey: I should say they are.

Mr. Lisberger: I presume there is no more inefficient type of lighting than the so-called electrolier lighting. An endeavor to produce a proper illumination has been made by one company—I don't know the name of the company that manufactures the electrolier—but it has got a little different shape of globe than that before used. I don't know whether you have seen it. There were some samples of it on Kearny street. The electrolier arm ordinarily coming out like this (drawing diagram) contains a globe something of that shape. In the San Francisco electroliers there are four of these downward, and one on top of the post. The new globe is shaped very much like this (drawing illustration); the lamp is visible if you get almost underneath the electrolier. This here is fluted, very much like a holophane—in fact it may be a holophane production—

Mr. Twomey: I do not recognize it.

Mr. Lisberger: They were first used in Cincinnati. The lamp is right in here (indicating), and if you get under the electrolier you can see it. It is not nearly as pretty a globe to the eye in daylight as the ordinary round shape of globe; but as far as area of illumination in its vicinity is concerned, and improving the lighting of the street, it is 50 per cent better than your old electrolier.

Mr. Twomey: The Holophane Company has a new lighting unit which consists of reflector shaped something like this, a prismatic reflector which has a similar distribution to that of the extensive type explained some time ago. The

prismatic reflector is surrounded by an opal envelope and has an ornamental holder at the top. The unit has a distribution curve something like this, the maximum occurring at such an angle as to avoid excessive glare and to give approximately uniform illumination with a ratio of height to spacing of approximately 1 to 4. With an opalescent ball with this same lamp you would have a distribution curve approximately like this; you will see that the two are radically different.

Mr. Lisberger: And it is a great improvement on the old type of electrolier.

Mr. Twomey: They may be located in a bad position so as to cause reflection from the paper back into the eye. The correct direction for light for reading is from over the left shoulder so that the light is reflected from the paper to the front instead of back into the eye.

Mr. Cory: If I say just a word here again, I think the point that has been discussed about street lighting and the minimum illumination, can perhaps be used directly in the illumination of a certain room. The room that Mr. Vincent had in mind and I had in mind is the reading room of the new Doe Library, the gift of Mr. Charles F. Doe to the University of California, which, if I am right in my recollection, is some 200 feet in length by 100 feet wide—

A Member: Fifty feet.

Mr. Cory: What I wanted to bring up is this. Might it not—if we cannot do this matter of specifying illumination for municipal lighting be a good idea in getting the illumination for such a room, to specify not only minimum illumination but maximum illumination as well. I remember quite well the work that was done in connection with that room; and I do not hesitate to say that the work was done along the line that has been brought out here this evening. The architect was not in sympathy with the work to be done at all. The situation was practically this: if all the lights in the room were put out except this one, and it were determined that the proper foot-candles on a table was correct for the average person reading, how shall we proceed in the most economical manner for the consumption of electric current to give a general illumination over the tables that are to be used, from the ceiling without the individual lamps? And I think, as has been brought out here this evening, if that particular problem in such a room as that is attacked in the right way we might get a general illumination, which would be not too much greater or too much less than you would get by your individual light. It is only carrying the point one step further, and not to stop with the minimum, but making it impossible to go beyond the maximum, particularly when the strain on the eye is to be considered.

A. J. Bowie: I might say a word in regard to the subject before us. In the Mechanics' Library the tables are arranged with very handsome two-light fixtures covered with green shades, and I have found a great deal of eye strain. I cannot say why it is, but presumably the high intensity and reflections; which is another point that should be considered. I would like to ask what results you get from indirect illumination. One gentleman I know has had very good results in a drawing room. He had four different candlepower lamps in a drawing room about a quarter as large as this room we are sitting in; and another example I have seen of it in the Wells Fargo Nevada Bank, where the illumination seemed to be bad indeed. Do I understand this matter of indirect lighting is in an experimental stage?

Mr. Twomey: It can not be figured as exactly as direct lighting, and the size and shape of the room are more important factors than in direct lighting. The method of calculation is not at present in as highly developed state as for direct lighting.

Mr. Bowie: What do you suppose was the matter down in the Mechanics' Library? I believe 25-candlepower tungsten lamps with green shades are used, and the lamps 16 to 18 inches above the table.

Mr. Twomey: They may be located in a bad position so you get a reflection from the paper back into the eye. The correct position for a light in reading is from the left shoulder, and the reflection goes away from the front of the light.

Mr. Cory: One question: Don't you think yourself, from your own experience, that you would not undergo that same eye strain if, instead of having these concentrated units close to you, allowing very great variation in the intensity of light, where you get the proper illumination, and then again practically none, there would be less eye strain if there were uniform illumination above, as in the case of daylight?

Mr. Twomey: Yes.

Mr. Cory: I think, when you come to the tungsten lamps, which is an economical means of consuming current, you have to go one step farther, and not locate them so close. Even in your reading room and library, get general illumination.

Mr. Babcock: I don't think the root of the matter has been touched yet. The human eye adapts itself to the maximum light, that is to say, the pupilary contraction comes in and the aperture closes automatically until the maximum light admitted is acceptable to the eye. Now when we are reading or drafting—anything of that kind—we are concerned with contrasts, and nothing else. The eye is picking out from a background a certain thing that the brain wishes to recognize. That may be type, or lines, or what not, but that contrast is what we are after. Now if on the page we are looking at there is a very brilliant light, the eye closes, the pupil closes to that illumination, and it is practically impossible to see the thing we are looking at. That can be tested by any one of us in a very simple manner. If, for instance, a source of light of this kind is available, simply turn your back on it, and just over the edge of your book put a bright light out in front of you, and how much are you going to see of that page? Nothing. It is the direct illumination of the source in front of you that your eye is accustoming itself to. Turn that light out, and at once the page appears to be brighter. It is not that the page is brighter, but the contrast between the maximum illumination coming into the eye, and the thing you are recognizing, is lost.

I have a photographic dark room, and I go on the theory that a maximum illumination in there is what I am after. It must be of a certain chemical quality. Consequently it is painted canary yellow to avoid reflections of stray light that might come in. If it wasn't that fear of a leak I would have the inside of my dark room as white as possible, but I want only the light yellow to be reflected in case of a leak. I have all the red light I need. There must be no green or yellow; it must be as near a chromatic red as can be obtained. The consequence is I can read a newspaper in the dark room. Why? Because my eye is concerned solely with the contrast between the black type and a certain background that looks red. Consequently I can see the black, and read any paper perfectly.

To me that is the theory of correct illumination to have as little light as possible to get the contrast. This idea of putting a light of high intensity down low on a desk and then attempt to work by it is rot. You tire your eye; and yet our architects will go on and on and do that very thing and keep on doing it. What is the purpose of the reading room? Is it to attract people to come in from the outside? No. It is a mere fool business method of an architect, who will erect an artistic establishment at the expense of the comfort and the use to which it is put.

Mr. Lisberger: Mr. Twomey, in some of the slides you showed, there was in the case of the holophane reflector a certain amount of light given behind the vertical line, up in here (indicating). Was that intentional or not? You had

some of your curves coming down like that (indicating).

Mr. Twomey: That is really intentional, because it is desired to have some light there. That ceiling reflection makes some increase over the illumination calculated by the "point by point" method. Where you have light walls and light ceilings it increases as high as 75 per cent in some cases, I think.

Mr. Babcock: I would like to add something to the remarks I have just made, illustrating the point that it is a question of contrast.

Those of you using a film on a kodak to take photographs know that on the little black piece of paper you pull out there are some spaces left for making notes. It is my habit in taking photographs to note on that little black slip of paper the length of exposure, the stock used, and whatever notes may be of value in the development of that particular film. When I take that into the dark room I use a black piece of paper with a lead pencil mark on it. One ordinarily would think this would be utterly illegible; but in the red light you have precisely the effect I speak of. The black paper is glazed, and reflects the light. The trace of the pencil on the paper does not reflect the light; and consequently you have the appearance of a dark line on a background that is easiyl seen. It is a luminous background for the time being reflecting the red light that you get, and the black pencil lines don't show. Consequently the black line on a black ground can be read as easily as on a piece of white paper here.

Mr. Lisberger: I think we owe Mr. Twomey a vote of thanks.

Mr. Babcock: I will be very glad to make a motion that he has our sincere thanks for this evening.

Mr. Lisberger: We have all appreciated Mr. Twomey's efforts on our behalf, and I am sure we have learned a great deal from his paper tonight. The meeting stands adjourned.

F. W. Loomis (contributed): On looking over Mr. Twomey's paper on "Methods of Calculating Illumination" I noted how thoroughly the subject had been covered.

Some of the tables used, however, are not as complete as they might be, and it may be of interest to those in the illumination field to see these tables augmented.

Under the heading, "Point by Point Method," Mr. Twomey truly states no account is taken of wall and ceiling reflection. A test was made some time ago by the engineers of the Holophane Company that has been developed into a table of very interesting figures.

The room where the test was made was 25 feet long, 12 feet wide and 10 feet high. Light and dark conditions of ceiling, walls and floor were tested. For the dark covering a very dark green burlap was used, while a light straw-colored semi-matte wrapping paper was chosen for the light conditions. The tests were made with one light source in the center of the room, close to ceiling, and again with three ceiling outlets. The first series of tests the lamps were clear and bare, while the second series, the lamps were bowl frosted and under extensive type of Holophane reflectors. With each of the above equipments (i. e., one or three-light sources and without or with reflectors) eight tests were made thus, giving all possible combinations of light and dark walls, ceiling and floor. The engineers were thus able to classify each increase. Not only did the expected increase due to light surroundings occur, but there also showed an additional increase due to what may be termed interaction of ceiling and walls. The summary in brief is as follows:

N1=Increase due to light ceiling alone.
N2=Increase due to light walls alone.
N3=Increase due to light floor alone.
N4=Additional increase due to interaction of light ceiling and light walls.
N5=Additional increase due to interaction of light ceiling and light floor.
N6=Additional increase due to interaction of light walls and light floor.
N7=Additional increase due to interaction of light ceiling, light walls and light floor.

NOTE: For complete data on this test see "Some Experiments on Reflection from Walls, Ceiling and Floors," by Lansingh and Rolph. Illuminating Engineering Society Transactions, Vol. 3, 1908, Page 584.

By analysis the following table of numerical values was obtained:

LIGHT SOURCE.

	1 lamp bare. Per cent increase.	1 lamp with refl. Per cent increase.	3 lamps bare. Per cent increase.	3 lamps with refl. Per cent increase.
N1..	79	33	96	29
N2..	63	19	77	26
N3..	11	5	1	0
N4..	53	23	54	37
N5..	6	0	6	4
N6..	5	12	11	11
N7..	42	58	60	45
Total	258	150	308	151

Of these only four are of material value.

N1=Increase due to ceiling alone.
N2=Increase due to walls alone.
N4=Increase due to interaction of ceiling and walls.
N7=Increase due to interaction of ceiling and floor.

The increase due to light surfaces is, of conrse, greatest when bare lamps are used as more light goes to the ceiling and walls; but the losses are proportionately greater if the reflection co-efficient of such surfaces are low. Thus is apparent the value of the redirecting power of a good reflector to control the light rays and send them in a useful direction. With the bare lamps, near the ceiling, the result would be an extremely brilliant spot on the ceiling around the source, which compared with less intensity over balance of ceiling, wall and floor snrface, again shows the need of the proper distributing reflector to give uniform illumination.

The following table applies in general for increase in actual over calculated illumination, in small or moderate sized rooms, when Holophane reflectors are used:

Condition of ceiling.	Condition of walls.	Increase over calculated illumination.
Very dark	Very dark	0%
Medium	Very dark	15%
Medium	Medium	40%
Very light	Very dark	30%
Very light	Medium	55%
Very light	Very light	80%

These figures should not be used in connection with the tables—Lumens per watt constants, Fig. 12, nor illumination constants, Fig. 13, of Mr. Twomey's paper, as in these tables consideration has been given to effect of wall and ceiling reflection.

Below is a more complete table covering the lumens per watt constant than that given in Fig. 12.

Note.—These constants are correct for the lamps only

WATTS REQUIRED TO ILLUMINATE A ROOM.

[illegible] following constants apply where there is a medium or [illegible] room; lamps hanging pendant 10 to 17 feet above floor.

Lamps.	Equipment.	Ceiling	Walls	Constant
[illegible] to 1.25 w.p.c.	Clear Holophane	Light	Light	5.0
" "	" "	Light	Dark	4.0
" "	" "	Dark	Dark	3.4
" "	Enamelled or satin finish	Light	Light	4.3
" "	" " " "	Light	Dark	3.4
" "	" " " "	Dark	Dark	2.8
[illegible] 2.5 "	Clear Holophane	Light	Light	2.2
" "	" "	Light	Dark	1.8
" "	" "	Dark	Dark	1.5
" "	" "	Light	Light	1.8
" "	" "	Light	Dark	1.5
" "	Lamps bare	Light	Light	.6 to 1.3
" "	"	Light	Medium	.5 to .8
" "	Opal Dome or Cone	Light	Dark	1.4
" "	" " " "	Light	Light	1.7

when operated at their rated watts per horizont[illegible] power. For lamps operating at other efficiencies [illegible] in this constant is universally proportional to the [illegible] watts per candle.

The following is a more complete table of [illegible] intensities recommended than will be found in Mr. T[illegible] Fig. 11. This table covers the various classes of [illegible] thoroughly:

Arcade (in addition to light received from show w[illegible]	[illegible]
Armory or Drill Hall	[illegible]
Art Gallery (walls)	[illegible]
Auditorium	[illegible]
Automobile Showroom	[illegible]
Automobile (interior)	[illegible]
Ballroom	[illegible]
Bank	[illegible]
Barroom	[illegible]
Barber shop	[illegible]
Bath (public)	
Dressing Rooms	[illegible]
Swimming Pool	[illegible]
Billboard	[illegible]
Billiard Room (general)	[illegible]
Billiard Table	[illegible]
Bowling Alley—	
Alley	[illegible]
Pins	[illegible]
Cafe	[illegible]
Cardroom	[illegible]
Carpenter Shop	[illegible]
Cars—	
Baggage	[illegible]
Day Coach	[illegible]
Dining	[illegible]
Mail	[illegible]
Pullman	[illegible]
Street	[illegible]
Courts—	
Handball	[illegible]
Squash	[illegible]
Tennis	[illegible]
Courtroom	[illegible]
Church	[illegible]
Club—	
For various rooms see B[illegible]	[illegible]
Dance Hall	[illegible]
Depot (waiting room)	[illegible]
Desk	[illegible]
Draughting Room	[illegible]
Engraving	[illegible]
Factory—	
General illumination only w[illegible] lumination of each [illegible]	[illegible]
Local Bench Illumination	[illegible]
Complete (no local) illumination	[illegible]
Fire Stations—	
When alarm is turned in	[illegible]
At other times	[illegible]
Foundry	[illegible]
Garage	[illegible]
Gymnasium	[illegible]
Hall—	
See Auditorium, Corridor or H[illegible]	
Hospital—	
Corridors	[illegible]
Wards (with local illumination [illegible])	[illegible]
Wards (with local illumination [illegible])	[illegible]
Operating Table	[illegible]
Hotels—	
Lobby	[illegible]
Dining Room	[illegible]
Writing Room	[illegible]
Corridor	[illegible]
Bed Room	[illegible]
Laboratory	[illegible]
Laundry	[illegible]
Library	[illegible]
Stock room	[illegible]
Reading room (with no local [illegible])	[illegible]
Reading room (with local illumination [illegible])	[illegible]
Lodge Room	[illegible]
Lunch Room	[illegible]
Machine Shop (general)	[illegible]
Market	[illegible]
Moving Picture Theatre	[illegible]
Museum	[illegible]
Office	[illegible]
Opera House (see Theater).	
Pattern Shops	[illegible]
Pool Room (general)	[illegible]
Pool Table	[illegible]
Power House	[illegible]
Postal Service	[illegible]
Press Room	[illegible]
Public Square	[illegible]

[illegible] (blue print) .. 2.0

[illegible] 2.0, 2.0, 2.0, 2.0, 1.5, .5, 1.5, 2.0, .7, .7, 2.0, 2.0, 15.0, 3.0, 2.5, 2.5, 2.0, 2.5, .8, .8, 3.0, 5.0, 8.0, 1.5, 16.0, 20.0, 8.0, 1.0, 2.0, 4.0, 1.0, 1.0, 3.0, .5, .1, .2, .05, 1.0, 2.0, 1.0, 8.0, 1.5, 1.0

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Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Nicola Tesla in a recent lecture promises the world that at an early date he will be able to transmit through the bowels of the earth selective wireless messages which can with ease be read in the heart of the Sahara Desert or in the great commercial centers by a receiver carefully tuned to that of the sender, wiping out all hitherto shortcomings of wireless telephony or telegraphy so far as impediments due to distance, location or interference are concerned.

Application High Frequency Tests

In these days of progress, scientists stand aghast, wondering what great advance will next be made. It is not necessary to speculate on future dreams and prophesies, however, for realities of the present afford us abundant food for thought. The intricate and delicate phenomena attendant upon high frequency variations seem to afford the greatest field for immediate useful application. Already it is bearing fruit. The study of the selective use of wave frequency of such lengths as are visible to the eye have resulted in enormous increases in lighting efficiencies. On the other hand, application of different wave frequencies in telephony have resulted not only in selective signalling, but also in the extension of the modern telephone use over distances that were thought absolutely impracticable but a few years back. These improvements in the telephone have resulted in its present almost indispensable use in the despatching of railroad traffic, both electric and steam.

As to Rate Reductions

Complete reports for 1907, the latest year for which full data are available, show that an average of 4.47 per cent interest was paid on the $600,677,685 outstanding bonds of electric light and power companies in the United States. On the $75,313,725 preferred stock an average of 3.21 per cent was paid in dividends and on the $666,003,772 common stock then outstanding an average of 2.53 per cent was paid. This is an average of 3.44 per cent paid in 1907 on a total capitalization of $1,341,995,182 for the electric light and power industry in this country.

The investors who received such small immediate returns on their money should be encouraged by the community's being thus provided with the greatest convenience of modern times. In lightening labor, dispelling darkness and diminishing distance, electricity has become well-nigh indispensable. But without capital it is well-nigh impossible. Yet capital, naturally timid, is scared away by arbitrary rate reductions and threatening municipal competition in a field which statistics show is little more than self-supporting. The investor is discouraged and forced to seek other channels, for money is fluid, though capital is not necessarily water. It is easily diverted by small obstacles.

These obstacles can be removed. Public service commissions are raising unreasonably low rates and stabilizing the business. Each year finds new uses and new users. The corporations are endeavoring to please those they serve and it only remains for a united public opinion to indose those optimistic men who are risking capital for public welfare.

Studies in High Tension Transmission

In our last issue brief allusion was made editorially, to the rapid advance in the use of high voltages for the electric transmission of energy.

It is interesting to summarize the experiences of three companies that have used 100,000 volts or over for a number of months and which were reported upon in detail at the recent Chicago convention of the A. I. E. E. The plants of these companies are situated in widely separated portions of the country; namely, the Great Western Power Co. has its plant in California; the Great Falls Power Co. in Montana, and the Southern Power Co. in Northern Carolina. All three use overhead grounded wires and string their power lines upon towers varying in distance from over 600 ft. in level country to over half a mile over billy country or water channels. Both stranded copper and aluminum are in successful operation. Two plants have been subjected to frequent lightning storms and in neither case has serious damage happened. In fact, a total shutdown of 30 minutes is the summary for eighteen months operation. The charging current in each case very nearly agrees with the computed currents, thus showing that mathematical processes can definitely foretell results of this nature. The suspension type of insulator seems to be the favorite, no serious trouble from either swinging of insulators or conductors having arisen. The question of opening the high tension side appears to have no more difficulty attached to it than those of much less voltages. The wind and sleet seem to have caused but little trouble. One plant reports that in a sixty mile per hour wind storm, it is their opinion that the wires of their transmission system will all sway sideways at approximately a similar angle of about 40 degrees and thus no trouble will be experienced one with another. Those presupposing corona effects from such high voltages found their prophecies unsubstantiated. The plant manager reporting the greatest corona effect states that this practically disappeared after three weeks' operation and accounts for its disappearance as being due to the rough points in stringing the wires having either been blunted or worn off during this period of service. The question of interference of telephone wires seems to have been properly handled.

At the same meeting of the A. I. E. E. above reported, the data collected from an exhaustive set of tests on the law of the corona and the dielectric strength of air were presented. It may well be stated that the laws of this hitherto uncertain phenomena have been finally and successfully solved for all practical purposes. Briefly, the corona losses have been found to be proportional to the frequency, to the square of the excess voltage above the disruptive critical voltage, to the square root of the conductor radius and inversely proportional to the square root of the conductor distance. It is found that atmospheric conditions have an influence also upon this loss; namely, smoke, fog, sleet, rain storms and snow storms lower the critical voltage and increase the loss, the effect of snow being greater than that of any other weather conditions. Humidity or "vapor products" have no effect on either critical voltage or the loss, while heavy wind has no effect on either at ordinary commercial frequencies.

It is difficult to say whether conditions in the near future will warrant even higher voltages and as to what the outcome of such an advance might be. This is certain, however, that present experience clearly demonstrates that voltages up to 100,000 are eminently practical.

Freight Traffic of the Interurban

It is interesting to note the ever increasing demands upon interurban electric service. Aside from bringing the people of the rural districts one step nearer to the pulsating life of the city, it aids wonderfully in the way of assuring rapid and cheap transportation of fruits and other farm products of a perishable nature. In the thickly populated regions of the Middle West this means of ready transportation of fruits has proven of wonderful service in the securing of maximum good results.

In order that fruit may bring the best prices it must be laid down in the heart of the fruit market comparatively fresh, be neat and attractive in appearance, and possess delicious flavor and other natural characteristics. Transportation by water is excellent when the same is of ready access, for the water, by cooling the atmosphere lowers the temperature some degrees, as a rule, and at the same time this mode of transportation is free from dirt and dust. But it is only in a few favored localities that water transportation is practicable. Unquestionably the next best mode is the electric interurban service. As an example of the many fruit-carrying interurban roads may be mentioned the Northern Electric Railway Company, operating between Chico and Sacramento, with about 100 miles of road, its entire length passing through a region almost exclusively given to fruit growing and farm products. This road has operated cars for the exclusive handling of fruit for the past four years and although at the time of starting the service this class of business was of a small extent, it has grown until today the revenue derived from this business helps considerably to swell the net income of the company. Success in this case is due not only to the fact that the farmer recognizes the value to be derived from shipping his fruit in this manner, but partly from the fact that the company has treated the small shipper exactly like the larger. If a man has but one case of fruit to be shipped he is shown the same consideration as the man who has a hundred. Under the system just cited one of the best evidences of the value of this service to the growers is shown by the fact that land readily accessible to the interurban has increased in value during the past few years about 30 per cent, while land at a distance has advanced comparatively little.

Many illustrations might also be cited from other interurban systems of the Pacific Slope which represent such an aggressive factor in our rapid growth. The opening of the Panama Canal will add much to our material prosperity. Our interurban systems will assure rapid transits of fruits to the Coast cities. Thence by water, the great markets of the world will be easily accessible. Such opportunities before us for commercial development we can hardly estimate!

PERSONALS.

Thomas Mirk of the firm of Hunt, Mirk & Co., is enjoying an outing at Lake Tahoe.

K. G. Dunn, of Hunt, Mirk & Co., has returned to San Francisco, after a trip to Denver.

J. M. Berkley, with the Edison Electric Company of Los Angeles, was at San Francisco last week.

John M. Gardiner, a veteran electric railway man of Los Angeles, was at San Francisco last week.

H. R. Noack, general manager of Pierson, Roeding & Co., has returned to his San Francisco office after visiting Denver on business.

R. D. Holabird, president of the Holabird-Reynolds Company, recently returned to San Francisco after spending a vacation at Lake Tahoe.

E. I. Pratt, advertising manager for the Kellogg Switch-Board & Supply Co., has returned to Chicago from a brief trip to the Pacific Coast.

H. L. Middleton of Boulder Creek, who has electric lighting interests in the Santa Cruz mountains, was a San Francisco visitor during the past week.

S. N. Griffith of Fresno, who has been prominently identified with the promotion and construction of electric railroads at Fresno, was a recent San Francisco visitor.

F. B. Gleason, Pacific Coast manager for the Western Electric Company is expected to return to his San Francisco office this week from a trip through the Northwest.

F. W. Cox, of Carson, Nev., has arrived at San Francisco en route to the Orient, where he expects to take charge of the agency for a large American electric manufacturing company.

M. C. Miller, assistant to the president of the Allis-Chalmers Company, returned to Milwaukee last week after visiting Fred L. Webster, the Pacific Coast manager, at San Francisco.

E. B. Spaulding, salesman with the engineering and contractors' department of the San Francisco office of H. W. Johns-Manville Co., is spending a month's vecation at Sioux City, Iowa.

F. O. Sievers, salesman with the Fort Wayne Electric Works, of the General Electric Co., is covering Southern California. J. A. Herr, of the Sprague Electric sales force is in the same territory on a business trip.

R. H. Fenkhausen, who for the past six years has been chief electrician at the Risdon Iron & Locomotive Works, entered the service of the Union Iron Works Company of San Francisco as electrical engineer, beginning July 1st.

The Oregon State Board of Health has appointed Louis C. Kelsey of Portland, Ore., consulting engineer to advise the Board in matters relating to municipal water supply and sewerage construction, including methods for sanitary disposal of sewage.

H. H. Noble, president of the Northern California Power Company, has just returned from a trip to the Coleman hydro-electric plant which is nearing completion. It is probable that current from this new development will be available [illegible] in August.

[illegible] R. Wilford, who has general supervision of hydro-[illegible] ction work on the Northern California Power [illegible], visited the San Francisco office last [illegible] making an observation tour of various power [illegible] State of California.

C. L. Harriman, an official of Chicago Street Railway lines, was a San Francisco visitor during the past week.

Louis C. Kelsey, Selling building, Portland, Ore., has been employed by the City of Gladstone, Ore., as engineer to prepare specifications, plans, estimates, etc., for a pumping plant and waterworks system. An election to vote $20,000 bonds for construction will be held July 31st.

G. A. Schneider, sales engineer with the San Francisco office of the Western Electric Company, recently returned from the annual conference of power apparatus specialists at New York City and nearby factories. During his return he attended the A. I. E. E. meeting at Chicago, and visited the company's offices at Chicago and Omaha.

F. L. McNally, district commercial superintendent of the Pacific Telephone and Telegraph Company, has been promoted and transferred to the Seattle district. The change caused several other promotions, District Superintendent F. F. De Lury, formerly at the head of the Oakland district, having taken McNally's place at San Francisco, and having been succeeded in turn, at Oakland, by H. C. Brownlee, the former commercial manager at that point. Maynard Bailey, formerly commercial manager at Berkeley, has been given the same position at Oakland, and B. A. Glover, the former contract agent of the Oakland district, has been made commercial manager at Berkeley.

NEW BULLETINS.

A unique bulletin has just been published by the Bridgeport Brass Company, entitled the "Line of Long Life." The bulletin sets forth the claims of "Phono-Electric" trolley wire in a very pithy yet attractive manner.

The Welsbach Company of Gloucester, New Jersey, have just published a new bulletin on "Filament Ignition of Gas." The paper is edited by the experimental engineering department of the Welsbach Company. In a logical sequence is reviewed filament ignition of gas by small platinum wire and giving finally a detailed description of the new ignition process now being put on the market by the company. The paper is both useful and instructive.

TRADE NOTES.

Contracts for tunnel work on the Oakland-Antioch electric road are being received at the local office of J. G. White & Co., 103 Edith St., Oakland, Cal.

A unique electric chocolate warmer is described in a pamphlet from the Cutler-Hammer Mfg. Co., Otis & Squires, of San Francisco being Pacific Coast agents.

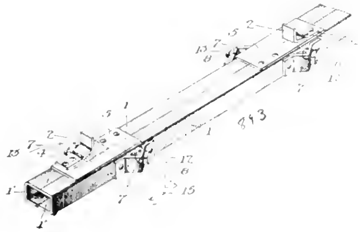
The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has received an order from the Oakland Traction Company, Oakland, Cal., for ten equipments of type HL (non-automatic) unit switch control.

The Fort Wayne Electric Works has sold to the Granite Gravel Company, San Francisco, a 125-h.p. induction motor for a gravel haulage engine, including swivel base, for use at Livermore. Also a 125-h.p. motor which will be direct-connected to a duplicate gravel hoist, built by the United Iron Works of Oakland for the same company.

The General Electric Company has sold to the Northwestern Pacific Railway Company a 500-kw., 3-bearing motor-generator set rated as follows: One A.T.I. 10, 660-k.v.a., 720-r.p.m., 2200-v., synchronous motor mounted on the same base with and direct-connected to one M.P.C. 4, 500-v., 600-v./600-v., compound wound railway generator with direct-connected exciter.

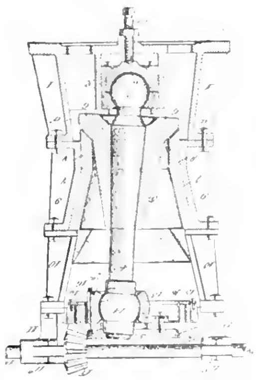
PATENTS

997,893. Metallic Railroad Tie. Oscar W. Beach, Los Angeles, Cal. A metallic railroad tie comprising two channel members extending side by side with their channels placed together forming a hollow tie, means clamping said channel



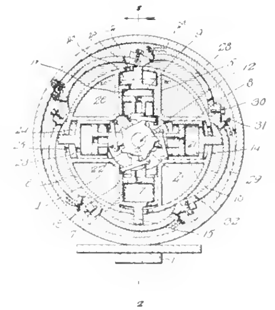
members together, said channel members being provided with lugs for engagement with the rail, and blocks within said channel members filling the same at portions adjacent to said lugs to form a reinforced support beneath the rail, and sound deadening filling in said blocks.

997,918. Rock Crusher. Adolph W. Jones, Oakland, Cal. The combination in a gyratory crusher, of exterior dies, and interior coacting shoes, a shaft upon which said shoes are carried, a ball in which the lower end of the shaft is stepped, a globular socket in which said ball is turnable, a corre-



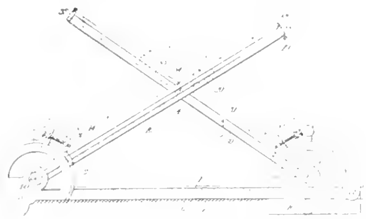
sponding ball and socket support for the upper end of the shaft, a horizontally turnable driving gear to which said ball and socket bearing is eccentrically connected, and means whereby the bearing is adjustable on the gear to vary the radius of gyration of the shaft.

997,824. Rotary Internal-Combustion Engine. Jacob Jacobsen, San Francisco, Cal. A rotary engine of the internal combustion type comprising a rotary shaft, a stationary member provided with a plurality of radially disposed cylinders, plungers fixedly supported at the inner ends of the cylinders and a circular rim connecting the outer ends of the cylinders, a rotary member fastened to said shaft and containing a plurality of combustion chambers, and pistons arranged to operate in said cylinders and provided with abutments to op-



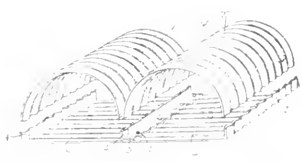
erate through said circular rim across the space of the combustion chamber in successive order.

997,826. Surveying Instrument. Paul Jones, Ontario, Ore., assignor of one-third to A. N. Soliss, Ontario, Ore. The combination of a base member, of a protractor secured at one end of said base member, a side member pivoted to said protractor, the pivotal bearing of said side member having an opening formed therethrough, a slide carried by said base



member, a protractor connected with said slide, a second side member pivoted to said slide, the pivotal bearing of said second side member having an opening formed therethrough, and means for pivotally connecting said side members, the pivotal bearing of said connecting means having an opening formed therethrough.

997,382. Culvert Structure. Charles A. Foster, Portland, Ore. A culvert structure comprising a base plate having upturned side flanges and an up-turned intermediate flange, and



a [illegible] arched top members adapted each to engage said intermediate flange and one of said side flanges.

INDUSTRIAL

WESTERN ELECTRIC PROGRESS ON THE PACIFIC COAST

BY G. A. SCHNEIDER.

Of the modern electrical supply houses on the Pacific Coast that of the Western Electric Company at San Francisco is the largest, and may also be considered as the oldest, as it was developed from the California Electrical Works, which was the first electrical supply house in the West.

Historically, this original company dates from 1877, when it was incorporated as the California Electrical Works, in which was consolidated the Electrical Construction and Maintenance Company—organized in 1868. The California Electric Power Company, the Pacific Electro-Depositing Works and the California Electric Gas Light Company.

In 1892 the California Electrical Works became identified with the interests of the Western Electric Company of Chicago, acting as Pacific Coast agents for the latter concern. The business continued under the original name until May, 1908, when it was changed to the Western Electric Company.

The offices and main warehouse of this company are located on the north side of Folsom street, at Hawthorne street, a small thoroughfare running parallel with and between Second and Third streets. The building consists of three sections, each of four stories, covering a ground area of about 300 by 150 feet and having 110,000 square feet of floor space. Certain sections of the building are used for warehouse purposes, another for manufacturing or shop purposes, while the fourth floor contains the offices of the company.

In laying out the building special care was taken to design it with due regard for safety from fire, with the result that the entire premises are of mill type construction, with walls of brick faced with red pressed brick, and the windows of wireglass throughout, all features being in accord with the fire underwriters' requirements. Under the rear courtyard there is a reservoir having a capacity of 120,000 gallons of water, while on the roof is a 50,000-gallon tank, which supplies water for numerous automatic sprinklers placed throughout the building.

The logic of this construction and fire protection was well proven during the great fire, when the entire building was saved.

To conduct the enormous business of this company, at San Francisco, requires a large investment and the services of from 250 to 300 people. A large portion of the investment covers the heavy stock of supplies, telephone apparatus, cable and power apparatus regularly kept on hand.

In addition to the building just described, the company maintain a large warehouse at Emeryville, California. Here they have available about 56,000 square feet of floor space in the building and 160,000 square feet of space in the surrounding yards, in which cable, poles and material of a similar nature are stored.

The company also have a pole yard at Weco, California, covering approximately fifteen acres. At this point a large and varied stock of poles—usually about 20,000 in number—are kept. This site was chosen as a storage yard on account of facilities afforded for handling boat shipments, all of the poles being shipped from the forests in Washington and Oregon in this manner.

A better idea of the volume of material handled by these houses may be gained from the statement that within the last year 301 full carloads of supplies were handled. This does not include the pole shipments received at Weco.

This well-selected stock is supplemented by a complete manufacturing plant on the third floor of the Folsom street building, enabling the company to assemble certain lines of apparatus to meet special requirements. This applies particularly to telephone switchboards and apparatus, and in these shops many of the private exchange boards used on the Pacific Coast are assembled. Ample facilities are also provided for all kinds of repairs and telephone and telegraph apparatus.

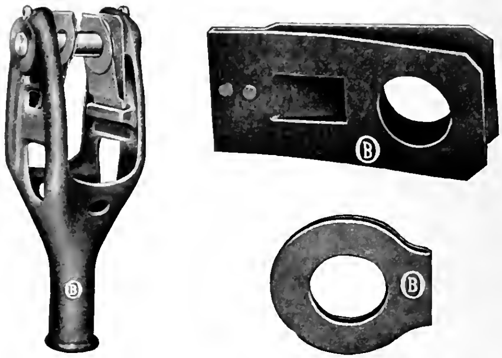
To further properly care for their business on this Coast, the Western Electric Company also maintain offices and warehouses at Los Angeles, Oakland, Seattle and Portland. The latter house is the latest to be established, having been put in operation last August.

Each of these houses carry complete stocks and are conducted along the same lines, thus insuring the same high-grade service all along the coast.

TROLLEY HARPS.

The Ohio Brass Company of Mansfield, Ohio, is listing a new design of trolley harp for which several commendable features are claimed.

The harps are so designed as to eliminate all sharp corners or projections which would be liable to catch in the overhead. Great strength has been obtained with light weight.



Clever Design of Trolley Harp with Phosphor Bronze Contacts

The body casting is made of malleable iron and is provided with a rope hole on each side so that it may be reversed when one side is worn.

The contact springs are made of phosphor bronze and are held in place without the use of any rivets or other fastening devices so that they may be easily and quickly renewed when worn. They are provided with reversible wearing washers which may be worn on both sides before renewal is necessary.

TRADE NOTES.

The San Francisco, Oakland & San Jose R. R. Co., San Francisco, Cal., has recently placed an order with the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., for 25 double equipments of No. 302 railway motors and type M control.

The General Electric Company recently sold to the Pacific Gas and Electric Company a 2-unit, 2-bearing, reversible, motor-generator set, consisting of one M.P.C., 8-pole, 1000-kw., 514-r.p.m., 550/600-v., compound wound, d.c. generator with commutating poles, direct-connected to one A.T.I., 14-pole, 1120-kw., 4000/2300-v., synchronous motor.

NEWS NOTES

FINANCIAL.

SALEM, ORE.—Articles of increase of capital stock have been filed with the Secretary of State by the H. M. Byllesby Company of New Jersey, increased to $6,000,000.

VANCOUVER, WASH.—The local plant of the Portland Railway, Light and Power Company, which was recently destroyed by fire, is to be rebuilt at a cost of $65,000.

SAN DIEGO, CAL.—Work which will cost the San Diego Consolidated Gas and Electric Company about $75,000 will begin as soon as material for underground wire conduits is received.

OROVILLE, CAL.—That the Sacramento Valley Power Company is planning an extension of its system to Oroville, as well as to other valley cities, became apparent when news reached Oroville that the company had mortgaged its holdings for $2,000,000.

FRESNO, CAL.—At the last meeting of the board of directors of the Fresno, Hanford and Summit Lake Railroad Company, all the debts of the company, contracted before the money for the building of the road was secured from the Guaranty Trust Company of New York, were liquidated. The total expenditures for these obligations amounted to $16,000.

REDDING, CAL.—It is learned that the $2,000,000 mortgage deed of trust by the Sacramento Valley Power Company, which was given for the purpose of taking up $400,000 of bonds of subsidiary companies, $600,000 will be used for enlarging the company's plants and extending its line and $1,000,000 will be held in reserve. This company is a combination of three older companies, the Sacramento Power Company, the Shasta Power Company and the Northern Light and Power Company. It has two power plants near Lassen Peak, each with a capacity of 2000 h.p. These will be increased to 7000 h.p. each. The company's transmission lines are to be extended to Willows and to a connection with the lines of the Great Western Power Company, from which it will buy additional power as needed. The Great Western is now under the management of the Fleishhacker interests and the Sacramento Power Company is controlled by the same parties. Mortimer Fleishhacker is president of the latter; Tilden Tognazzini, vice-president; Samuel Napthaly, general manager, and A. W. Smith field manager. It is understood that with its own output and its supply from the Great Western, the Sacramento Valley Power Company will distribute in the neighborhood of 40,000 h.p. It will cover the field from Chico north to Redding.

INCORPORATIONS.

JACKSON, CAL.—Articles of incorporation of the Mokelumne River Power Company have been filed with the County Clerk.

OAKESDALE, WASH. The Oakesdale Home Telephone Company has been organized with $10,000 capital. A. Woodward and Ed Roberts are among the trustees

SAN FRANCISCO, CAL.—The California Consolidated Light and Power Company has been incorporated with a capital stock of $5,000,000 by C. S. Goodrich, J. T. Pigott, T. E. Palmer, Grover O'Connor and G. R. Ray

SAN FRANCISCO, CAL.—The Somerset Mutual Water Company has been incorporated with a capital stock of $60,000; subscribed, $900. The directors are A. F. Jelinck, W. J. McGimpsey, W. C. Emerick, R. F. Hammond, J. E. Cohn, C. W. McKee, A. H. Drum, G. W. King, B. A. Guernsey.

SAN JOSE, CAL.—A copy of the articles of the Union Water Company of California has been filed here by Pillsbury, Madison & Sutro of San Francisco, attorneys for the concern. The company is incorporated for $5,000,000, to carry on a general business of a public service corporation. There are 500,000 shares of the capital stock, 300,000 of which are common and 200,000 preferred. The stock so far actually subscribed has been 50 shares of the common stock at $10 a share, and this stock is held in equal proportion by each of five directors—Wm. T. Barnett of Berkeley, Alfred D. Plaw of Oakland, Platt Kent and V. W. Vincent of San Francisco, and F. D. Madison of San Rafael. Their place of principal business is San Francisco, and the articles of incorporation were issued by the Secretary of State December 21st last.

ILLUMINATION.

LOS ANGELES, CAL.—The Guy M. Rush Company, which is developing Lawndale, expects to have a first-class electric lighting system in the very near future.

SEATTLE, WASH. A bill has been passed authorizing the city engineer to expend the sum of $20,000 for surveying the new Cedar River water shed and the sum of $400,000 for the new dam.

TRANSMISSION.

LEAVENWORTH, WASH. The Council has granted to the Washington Steel and Iron Company a franchise to construct and maintain a transmission line in the town of Leavenworth.

AUBURN, CAL.—The Board of Supervisors has granted to the Great Western Power Company a franchise to erect and operate a transmission line upon the roads of the county of Placer.

LOS ANGELES, CAL.—A franchise has been granted to the Pacific Light and Power Company for a power line to be installed in the foothills district east of city limits of Los Angeles and extending to Pomona.

TUCSON, ARIZ. H. A. Smith has taken steps towards the establishment of a big power and irrigation project near Noria, Sonora, which will furnish power to four mines and smelters and the town of Llano and water for irrigation of 15,000 acres.

VALLEJO, CAL. The Pacific Portland Cement Company has made application to the Board of Supervisors for a franchise to erect and maintain poles and wires for the transmission of electric light, heat and power upon certain highways in Solano County.

SAN FRANCISCO, CAL.—To supply a great part of the lower end of the San Joaquin Valley, especially the West Side oil fields, with power, the San Joaquin Light and Power Company expects to turn on the current in the big Bakersfield main line this week. With three small ends of the big work of installing this line and all the connected sub-stations yet to be done, it is believed the wire will be carrying its full 60,000 volts in a few days. Over on the West Side, where the main line runs, there are now five miles open between the ends of the wires. These five miles are being held open to wait for insulating. As soon as this arrives, the line can be connected up with little effort. The control station for this

line, which is located at Fresno Copper Mines, northeast of Clovis, is finished except for some of the connections which will be the last part of the job done. This wire, with its capacity of 40,000 volts, is to be the highest power line in the field here. The company is now commencing on the survey for the Dos Palos, Los Banos and Gustine line. This work will be through very shortly, because of the easy country traversed by most of the line, and the delivery of poles will begin at once. Up at Crane Valley the job will keep the people busy until along in August, because hand placing of riprap work in the dam has to be done, and this is the slowest part of the entire job. In the power house only five more heavy pieces have to be placed, and these will be in within a week. McKittrick is now being wired with the intention of getting the current for lighting and other purposes there by the middle of July. Work on the sub-station there is progressing well. Light is also to be furnished to several places in Reward.

TRANSPORTATION.

PASADENA, CAL.—Work will start in a short time electrolizing the Southern Pacific tracks from the station at Colorado street, Broadway to Bellevue drive

SAN BERNARDINO, CAL.—The application for a franchise for an electric line through the streets of the city, applied for by F. A. Worthley, has been ordered advertised for sale.

BOISE, IDAHO.—Considerable local interest attaches to the surveying of a line for an electric railway between Nampa and Caldwell by surveyors in the employ of Walter Sebree of Caldwell.

CHICO, CAL.—The Northern Electric Railway Company has made application for a franchise to operate a railroad of standard gauge with single or double tracks in the streets of the city of Chico.

SAN BERNARDINO, CAL.—Plans for a right of way from Urbita Springs to Colton have been formulated by the Chamber of Commerce. The Pacific Electric has advised immediate construction and its ultimate connection with Riverside extension to Highgrover as soon as the right of way is secured.

SACRAMENTO, CAL.—An application for a franchise to extend the street car system through the suburbs to the east and southeast of the city, making several loops, was made to the Board of Supervisors this week by the Sacramento Electric, Gas and Railway Company. The application covers three sections of single or double tracks as the company may hereafter decide.

PORTERVILLE, CAL.—In anticipation of the construction of the main power plant of the Tulare County Power Company, officers of the company are now securing rights of way for an electrical railroad line which will connect Porterville with Lindsay on the north and Tulare on the west and which will tap the entire orange and dairy district of eastern Tulare County.

TELEPHONE AND TELEGRAPH.

ASTORIA, ORE.—The Nehalem Valley Company has been incorporated and will operate and construct telephone lines.

CENTRALIA, CAL.—The Hanaford Skookum Telephone Company of Centralia has been incorporated for $1500 by A. [illegible] and W. Eshon.

TACOMA, WASH. The Sunset Telephone Company has awarded a contract to Westerfield & Van Buskirk of this city for the erection of their sub-station on Seventh and Proctor [illegible] at a cost of $25,000. They will also erect another [illegible] in the south end of the city.

EUGENE, ORE. The government will construct 35 miles of phones in the forest district, also a branch line from Box Canyon to Waldo Lake.

WINONA, WASH.—The farmers north of this town are building a telephone line into their country to connect with the Winona system at the Muir place.

DAVENPORT, WASH.—W. N. Purdy, manager of the Washington Consolidated Telephone Co., has about completed a survey between this place, Fruitland and Hunters for the installation of a toll line.

KALANA, WASH.—The Mt. Pleasant Telephone Company has presented the County Commissioners of Cowlitz County a petition asking for a franchise to erect a telephone line over certain streets in said county.

SAND POINT, IDAHO.—Le Roy H. Whitcomb has been granted a franchise to maintain poles and wires on the streets of Clarksfork for the purpose of supplying the public with communication, for a period of 50 years.

MARSHFIELD, ORE.—The franchise held by J. M. Blake for the construction of an electric car line has been forfeited, on account of not complying with the specifications, which stated that he should have one mile of track completed by July 1.

RENO, NEV. A number of Reno men are now working toward a plan to bring the Home Telephone Company into Reno to compete with the Pacific Telephone and Telegraph Company. The agent of the Home company has been in Reno for some time.

VANCOUVER, B. C.—The British Columbia Telephone Company has made application to the Governor in council for authority to construct an aerial wire crossing over the Fraser River from a point at the westerly end of Choam Slough to the south bank of the river.

WATERWORKS.

BAKERSFIELD, CAL.—The Electric Water Company will put in a plant in East Bakersfield capable of supplying that part of the city with water.

PORTERVILLE, CAL.—The $60,000 bond issue has been carried by a large vote; $43,000 was voted for waterworks and $13,000 for street improvements.

LOS ANGELES, CAL.—An ordinance has been adopted granting to Samuel M. Walker a franchise for a water system in certain portions of Los Angeles County.

SAN DIEGO, CAL.—An assessment has been levied on the stock of the Escondido Mutual Water Company to replace the wooden flumes with cement ditches and tunnels.

NOGALES, ARIZ.—An election is to be called for Nogales to vote on an issue of $100,000 bonds for a water system and $60,000 for a [illegible]er system, the election to be held August 10th.

MEDFORD, ORE. [illegible]e Council has resolved to lay a 6-inch water main on R[illegible]s[illegible]velt avenue, protests against which will be heard on the 18th of July at the Council chambers in the City Hall.

HERMISTON, ORE.—An election will be held August 7th to decide on a $25,000 bond election for the construction of a municipal water system. Bonds for $4000 will also be voted for a city park.

MARSHFIELD, ORE.—Thos. P. Nolan, an attorney, of Omaha, has completed negotiations for the purchase of the Coos Bay Water Company from Flanagan & Bennett. He has applied for a franchise to construct a water system in the city of Marshfield.

JOURNAL OF ELECTRICITY
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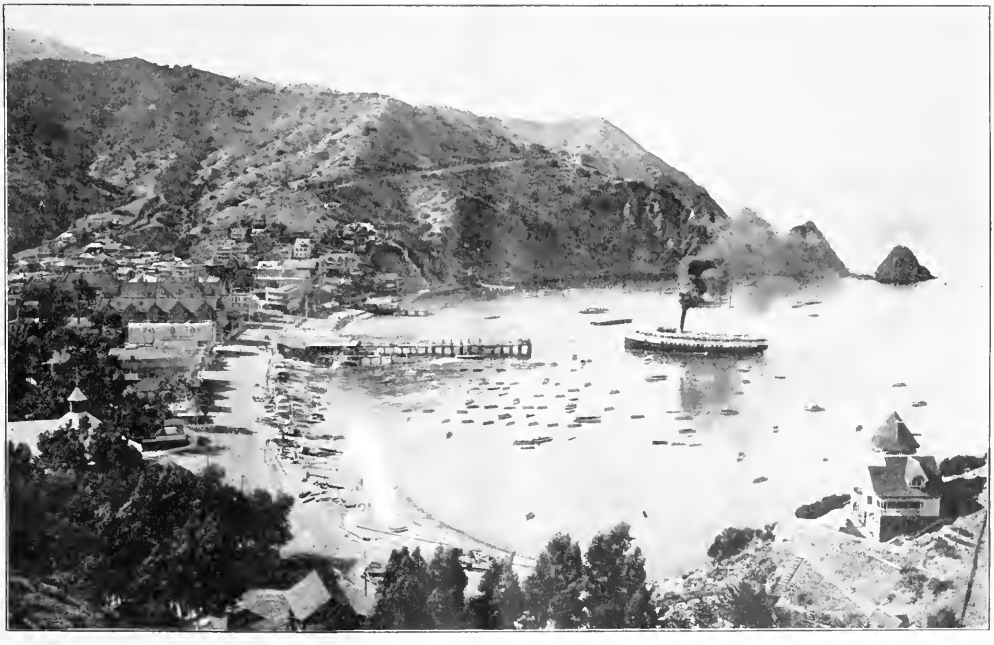
VOLUME XXVII SAN FRANCISCO, JULY 29, 1911 NUMBER 5

CALIFORNIA CONTRACTORS CAMP AT CATALINA

The electrical contractors from all over California pitched their tents at Catalina Island during the second week of July. The northern delegation left San Francisco on July 8th, going down the coast by steamer and arriving at San Pedro on Sunday morning. Here they were met by the reception committee and escorted in special cars to the Lankershim Hotel at Los Angeles where temporary quarters were established. In the afternoon the visitors were entertained by an automobile trip along the beach resorts and through the beautiful residential section of the southern city.

Monday morning two special cars carried 150 contractors and their families to the steamer Cabrillo on which they sailed to Avalon Bay. Tents were provided for all and the joys of camp life commenced. After an early morning dip on Tuesday, the contractors convened in the ballroom of the Metropole Hotel with W. S. Hanbridge in the chair. Upon roll call eighty contractors qualified from San Francisco, Stockton, Sacramento, San Jose, Palo Alto, Redwood, San Mateo, San Diego, Los Angeles, Pasadena, Santa Barbara, Ventura, Pomona and Riverside. During the



Picturesque Avalon—Catalina Island, where Convention was Held

F. R. Carroll [H. Davis B. T Griffith A. E. Ridley N. Hope H. Miller G. Arbogast J. S. Reynolds A. P. Gaylord W. A. McNally L. Gans F. E. Meyers Noble Powell H. P. Woodill P. Levy W. S. Hanbridge, Sec'y and Treas.

afternoon the ladies of the party viewed the wonders of the sea through the glass bottomed boats, being joined late in the afternoon by the male contingent who enjoyed a moonlight boat ride. A band of minstrels furnished the music until a late hour, when the crowd returned to their tents.

On Wednesday morning the ladies enjoyed a coaching trip as the guests of one of the manufacturing companies. Meanwhile the contractors were in executive session, busy with matters of trade interest. A concert and dance furnished amusement for the evening.

The Finish of the Fat Woman's Race.

On Thursday morning, after a vigorous campaign of electioneering, officers were elected for the ensuing year. The president's chair, which had been held by W. S. Hanbridge for the last two years, was filled by the election of John Rendler of Los Angeles, both Mr. Hanbridge and Mr. Woodill declining to run. After a spirited contest Carl Heilbron of San Diego was elected first vice-president, and J. S. Reynolds of Santa Barbara second vice-president. W. S. Hanbridge was chosen to fill the duties of secretary and treasurer, which were declined by F. E. Meyers, the incumbent. R. S. Booth was elected sergeant-at-arms. New committees were appointed to take care of the matters of supply, state license, permanent by-laws and central station policy. Each committee was instructed to promote a closer working relation between the jobber, manufacturer, central station and contractor. Final adjournment of the business meetings was taken at 1 p. m.

Later in the afternoon an open meeting of the contractors and guests was addressed by S. M. Kennedy of the Southern California Edison Company who gave an instructive talk, clearing up a number of obscure points in the contracting business. Col. H. V. Carter addressed them on the cost of doing business and the ideal relations that should exist among competitors, being greeted with great applause when he had concluded. The final paper was read by Bert Fanning and covered the cost of conducting an electrical contracting business. This paper will appear later in these columns.

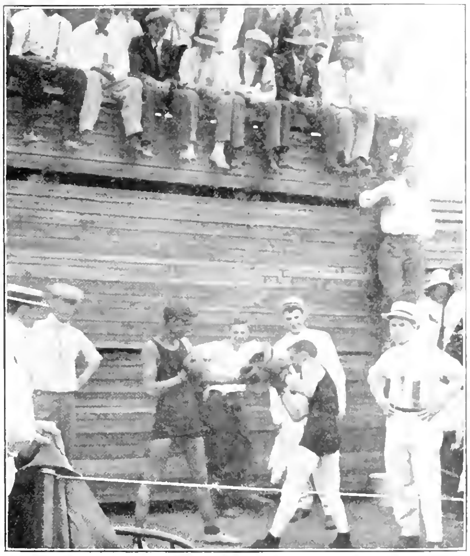
In the evening nearly two hundred contractors, jobbers, manufacturers, central station men and city inspectors, with their wives and sweethearts, enjoyed a fine banquet provided by genial hosts from Los Angeles and Pasadena, the dinner being followed by dancing.

On Friday morning, all business having been concluded, the entire party were taken to the Isthmus on three launches, where a big lunch was spread and a good time provided by the entertainment committee,

They Were All There—

T. Rendler. Pres. Elect, Chick Ames, H. Ross, F. Potter, G. Loveberg, D. W. Somers, E. Fleishman, Chas. Holland, O. Overholtzer, L. R. Boynton, G. Happs, R. Booth, C. Loveday, E. Shafer, F. M. Neilson, M. N. Phillips, Seth Cohn

Messrs. Booth, Gans and Fleishman. Athletic sports were the order of the day, starting with a seven-inning baseball game between the northern and southern contractors, this being won by the southerners with a score of 11-22. Chas. Holland won the prize for making



Jim and Lil Arthur in "Squared Circle"

the greatest number of runs, and Messrs. Burger and Cole acted as umpires. This was followed by a ten-inning game between the contractors and the supply men, the former winning with a score of 24-16. At the end of the first half of the ninth inning the score was 14-7 in favor of the contractors, but Manager Geo. Cole rallied his hired men so that the score was evened, but the pace subsequently proved too fast, for them, as the contractors made eight runs in the tenth inning as compared with two made by the supply men.

On the track, the 100-yard dash for members was won by Arbogast, Duncan and Potter, making second and third respectively. The 50-yard dash for ladies

The Start of the Fat Man's Race.

was captured by Mrs. Colkitt with Mrs. Miller and Mrs. Loveberg closely behind. The 100-yard dash, free-for-all, was won by Spring, Johnson second. In the 25-yard sprint for ladies of 160 lbs. or more, Mrs. Rendler came in first with Mrs. Booth and Miss McGinty second and third. The 50-yard dash for Misses was won by Miss McCain, Miss McGirty and Miss Call missing the first place. The contestants in the fat man's race, making the first three places, were Messrs.

Catalina Island, July, 1911.

Jobbers vs. Manufacturers and Supply Men Baseball Team.

Morris, Reed and Woodill. The race for boys under nine years was won by Master Beecher, with Masters Woodill and Ames close behind. The swimming contest was won by Burger, Carroll second; the bowling by Arbogast and the wrestling by Fanning. Spring crowned his achievements and enriched his backers by almost two dollars in winning a race with the local champion.

A four round boxing contest was staged between Jim Jeffries and Jack Johnson. Johnson got the worst of it at the start, but rallied by the sympathy of the ladies Lil Arthur finally floored Jeffries, who was counted out by Referee Booth.

The prizes were awarded in the evening, most of the party retiring early to prepare for the next day's fishing. Piscatorial honors were awarded Chick Ames, Harry Sayles and Pop Boynton.

Sunday night and Monday morning found the crowd homeward bound after this most successful get-together meet of competing contractors.

Picturesque Avalon has justly gained a national reputation as a place to spend a summer's outing. The glass-bottom boats, the deep green sea beneath and the clear blue sky above present many f[illegible]ful and delightful sensations to the weary wanderer seeking rest from the cares and toils of the year. So it was that the California contractors at their camp in Avalon found their little outing most enjoyable and highly profitable in every respect. Many little side affairs were enjoyed immensely in addition to the regular program of the convention. Among one of the most enjoyable of which was the dinner given at Catalina Island during the convention by Messrs. and Mesdames Abrogast and Potter to the following starving manufacturers and jobbers' representatives: Messrs. Sayles, Herr, Steel ,Bortel and Drake.

One of the most beneficial features of such gatherings as the California Contractors at Catalina Island, is the interchange of ideas and the forging of a bond of mutual friendship and support. The friendships made in these moments of leisure are of a most lasting nature. The calling to mind of the happy times spent on such occasions makes the pathway easier and softer in the coming year's labors when contractor again meets contractor, though this time it may be in competition. Perhaps discord, strife and misunderstandings may arise, but again in the next season's meeting they will all be forgotten. There is a feeling of comradeship which naturally arises among men associated in a common vocation. This feeling is by nature of their work, by common sympathy and endeavor, of high order among those engaged in contracting. Such times as were had at Avalon, however, heighten this feeling to the highest degree and will long remain in memory among the brightest and happiest of a lifetime.

Northern vs. Southern Contractors Baseball Team.

NEW EXPERIMENTS ON INCREASE OF WIND PRESSURE UPON SMALL WIRES.

BY F. C. PIATT, H. S. LANE AND L. A KISTLER.

In the design of an electric power transmission line there are three main forces which the structure must be designed to resist; (a) the dead weight of the wires, (b) the horizontal tension of the wires due to the flat catenaries assumed when strung, (c) the side strain due to wind force on wires and structure. Of these forces the dead weight in many cases is very small compared with the others. The horizontal tension is important in that it limits the allowable span for a given height of structure in flat country, since certain minimum ground clearances must be observed, and the sag, and therefor the span for a given height of structure, is determined by this tension. When the line is strung the pull of the wires counter-balance at each pole and creates no net pull except in case of breakage of a wire, angles in the line or uneven spans. In the use of the suspension type of insulator this unevenness is automatically connected.

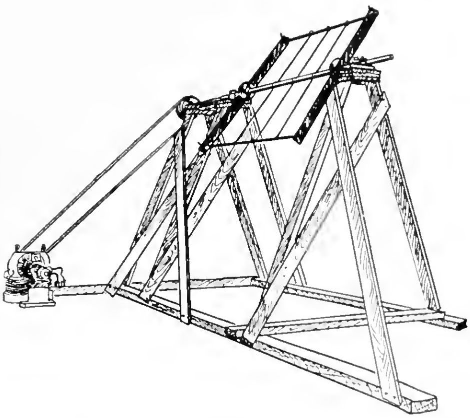


Fig. 1.

The wind force is, however, active on all poles or structures, and is the force which limits the allowable length of span in hilly country. Deep valleys may permit the use of very long spans so far as weight or horizontal tension are concerned, whereas the possible wind forces acting on the wire may cause greater stresses in wire or structure than are allowable.

These wind forces have usually been calculated in accordance with the rule given by Prof. Kernot, who states (in the Engineering Record of Feb. 20, 1894) that the pressure due to wind on cylinders (wires) is one-half that on flat plates of equal areas. This rule has been very generally followed; for example, by F. O. Blackwell in a paper on "Long Spans for Transmission Lines" presented before the A. I. E. E., June 21, 1904. Following this rule a pressure of 20 lbs. per sq. ft. of exposed area of wire has been widely adopted, corresponding to a pressure on flat surfaces of 40 lbs. per sq. ft., which is given as the wind pressure at a wind velocity of 100 miles per hour.

It seemed very doubtful to the authors of this series of tests that the pressure on wires would be independent of diameter as indicated by Kernot's rule. Apparatus was therefore arranged to actually measure the forces acting on wires of ordinary commercial sizes when exposed to winds of definite velocities. Enough wires were to be tested to find the variation of wind force with wire diameter, if it existed. Cables were also to be tested, as it seemed probable that they would give results differing from solid wires of the same diameter.

The apparatus used is shown in Fig. 1. The general arrangement is so clearly shown that explanations seem unnecessary. The principal dimensions are as follows:

Height of shaft from ground	5 ft. 6 in.
Clear distance between arms	4 ft. 0 in.
Length of arms	4 ft. 2 1/16 in.
Radius of Arms to holes bored for wires	2 ft. 0 in.
Width of arms	2 9/16 in.
Thickness of arms	¾ in.

Two precisely similar pieces of wire were mounted between the arms, parallel with the shaft, as indicated in the photograph. The wires, being placed as far as possible from the axis, and rotating in a cylindrical surface, were in a position to show their maximum wind effect. The shaft was belted to the motor and speeded up until the tangential velocity of the wires was about 120 miles per hour, when the belt was thrown off and the apparatus slowed down under the influence of friction and windage.

Deceleration curves were obtained by means of the tachometer attached to the machine and a chronograph, the observer closing the chronograph circuit at the instant the tachometer needle indicated 800, 750, 700, etc., r.p.m., thus obtaining a speed time record on the chronograph tape. Runs were made with the test wires in place, and without them ("Zero Runs"), thus allowing the effect of the test wires to be separated from that of the rest of the apparatus.

Owing to the severe normal forces acting on the wires when in rotation it was necessary to tie them in to the shaft at intervals along their length with tie wires. During the "Zero Runs" these tie wires were kept in place by means of fine piano wires mounted in place of the test wires. Due allowance was made for these piano wires by means of a separate run using additional wires of the same kind outside the "Zero Run" wires.

Various sizes of wire were thus tested, and also three samples of cable, the cable being that used by the Great Western Power Company for ground wire (lightning arrester), for ordinary spans, and for river crossings (Monott cable).

The following notation is used throughout this article:

P = force, lbs. weight.
N = revolutions per minute.
W = weight in lbs.
$\backslash$ = angular velocity, radius per second.
T = time, seconds.
I = moment of inertia about the axis of rotation.
h = lever arm, feet.
ω = angular velocity (radians per sec.)
K = A constant for any one wire.

In general from the study of mechanics we learn—

$$Ph = I \frac{d\omega}{dt}$$

$$\text{but } \omega = \frac{2\pi N}{60} \quad \therefore \quad d\omega = 2 \frac{\pi}{60} dN$$

And therefore, in general

$$Ph = \frac{2\pi}{60} I \frac{dN}{dt}$$

In our calculation we found $\frac{dN}{dt}$ by a method equivalent to a graphical differentiation of the curve $N = f(t)$.

That is, we measured dt between successive 50 r.p.m. readings on the chronograph tape, and considered this d t applied to the mean r.p.m. of the interval. These values are given in Table 1 for No. 0000 copper wire and in Table 11 for No. 19 B. W. G. That is.

TABLE 1.

Run. N	1 Zero t	1 Zero dt	2 Zero t	2 Zero dt	3 No. 0000 t	3 No. 0000 dt	4 No. 0000 t	4 No. 0000 dt
800	.46		.10				.51	
		1.27		1.32				.65
750	1.73		1.42				1.19	
		1.27		1.26				.63
700	3.00		2.68		.29		1.82	
		1.47		1.32		.89		.66
650	4.47		4.00		1.18		2.18	
		1.62		2.00		.82		.92
600	6.09		6.00		2.00		3.10	
		1.91		2.00		1.00		1.10
550	8.00		8.00		3.00		1.50	
		2.27		2.00		1.20		1.01
500	10.27		10.00		4.20		5.51	
		3.23		3.00		1.45		1.63
450	13.50		13.00		5.65		7.14	
		3.32		3.68		2.20		2.00
400	16.82		16.68		7.85		9.11	
		1.93		4.62		2.38		2.51
350	21.75		21.30		10.23		11.65	
		6.25		6.40		3.47		3.15
300	28.00		27.70		13.70		15.10	
		8.29		8.30		4.71		1.55
250	36.29		36.00		18.41		19.65	
		11.71		11.60		6.86		6.92
200	48.00		47.60		25.30		26.57	
		16.20		17.40		12.10		11.13
150	64.20		67.00		37.40		38.00	

TABLE 11.

Run N	33 Zero t	33 Zero dt	34 No 19 B W.G. t	34 No 19 B W.G. dt	35 No. 19 B.W.G. t	35 No. 19 B.W.G. dt
800	.26		.40		.69	
		1.34		.60		.92
750	1.60		1.00		1.61	
		1.11		1.11		1.23
700	2.71		2.11		2.84	
		1.54		1.44		1.16
650	4.25		3.55		4.00	
		1.62		1.36		1.61
600	5.87		4.91		5.61	
		2.30		1.83		2.04
550	8.17		6.74		7.65	
		2.54		2.16		1.95
500	10.71		8.90		9.60	
		3.07		2.78		2.89
450	13.78		11.68		12.49	
		3.61		3.32		3.21
400	17.39		15.00		15.70	
		5.01		4.35		4,30
350	22.40		19.35		20.00	
		6.75		5.65		5.40
300	29.15		25.00		25.40	
		9.85		7.53		7.94
250	39.00		32.53		33.34	
		13.51		11.07		11.59
200	52.51		43.60		44.93	
		20.31		17.80		18.47
150	72.82		61.40		63.40	

dN = 50 was varied at intervals throughout the work (the tachometer readings were correct at all speeds), and dt at any speed was taken from the curves, plotted from the data so compiled. Fig. 2 and 3 show the curves for No. 0000 wire and No. 19 B. W. G. Let

I_o = moment of inertia of apparatus including tie and "zero" wires.

I_w = moment of inertia of wires.

I = moment of inertia with test wires.

Then the force moment for the "Zero Runs"

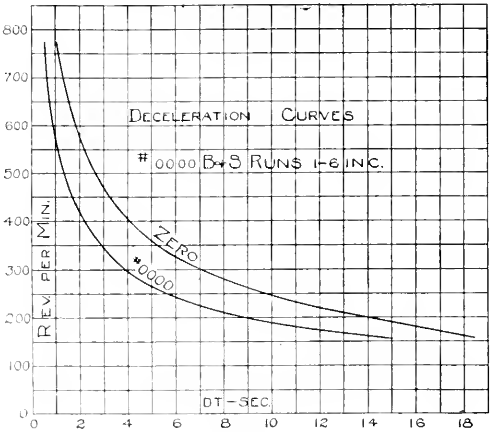


Fig. 2.

$$P_o h_o = \frac{2\pi}{60} I_o \frac{dN}{dt_o} = \frac{K_o}{dt_o}$$

For the test runs

$$Ph = \frac{2\pi}{60} I \frac{dN}{dt} = \frac{K}{dt}$$

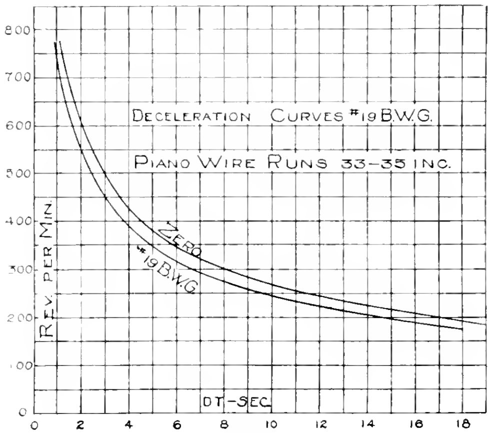


Fig. 3.

I was found by weighing each part of the apparatus and from its dimensions computing its moment of inertia about the axis of rotation.

We neglected the moment of inertia of the wire about its own axis in figuring I_w, that is $I_w = \frac{wh^2}{g}$

The moments of inertia are tabulated below:

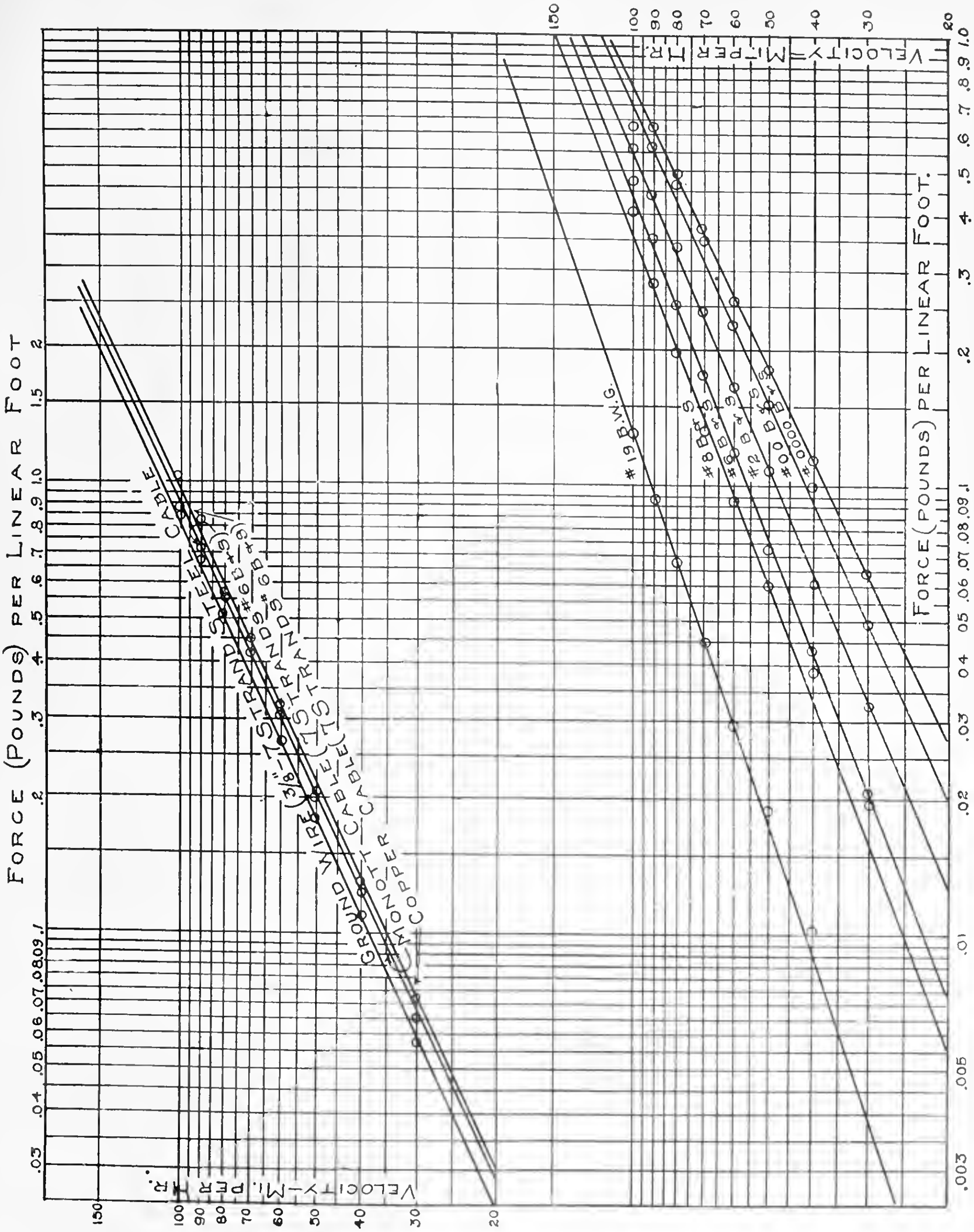


Fig. 4.

Member	Weight	Formula	Moment of Inertia
2 arms	53.55	$M\left(\frac{h^2}{3}+\frac{a^2}{12}\right)$	2.422
Shaft	39.26	$M\frac{r^2}{2}$	.001654
Collars	2.38	$\frac{M}{2}\left(r_1^2 - r_2^2\right)$	.000225
Flange No. 1	3.75	$\frac{M}{2}\left(r_1^2 - r_2^2\right)$	.00284

The run for No. 0000 wire made with pulley No. 1, while that for No. 19 B. W. G. with pulley No. 2. For the two cases respectively

$I_0 \doteq 2.463 +$ mom. of "Zero wires."
$I_0 = 2.484 +$ mom. of "Zero wires."

All the calculations are arranged in the tables, which are self-explanatory.

Calculations based on the deceleration curves are shown for No. 0000 wire in Table III, and for No. 19 B. W. G. wire in Table IV. Values of dt correspond-

ing to even tens of miles per hour were read directly off the curves. Curves plotted from these tables are given in Fig. 4 were plotted from values (marked "true" in tables) taken from Fig. 4. Fig. 7 was plotted from values calculated from Fig. 6, and the two curves compared, any small discrepancies being smoothed out. This process, as can be seen, tended to weed out experimental errors. Fig. 8 was then plotted from Fig. 6 and exterpolated as indicated.

An attempt was made to express the force on any round wire in terms of wind velocity and wire diameter, that is, in an equation of the form

$$P = KV^{f(d)} F(d)$$

The curve in Fig. 5 was plotted to show the variation of exponent (f(d)) of V with diameter. The fact that the plotted points fit a smooth curve nicely indicates that there are probably no gross errors in the work. The curve fits quite accurately the hyperbolic equation.

$$f(d) = 1.55 + \frac{.405}{.25 + d}$$

Considering Fig. 8 we found that F(d) is not a simple function of d, for instance, an exponential, but

TABLE III.

Wire, No. 0000 B. & S.
Weight = 5.22 lb.
Mean diam. = .460 in.
Mean h = 2.0118 ft.
Iw = .660.
Io = 2.463 + .004 = 2.467.
I = 2.463 + .660 = 3.123.

Mi. hr	dto	Po ho	Net Po ho	dt	Ph	Net Ph	P per lin. ft Obs.	P per lin. ft True	True P per sq ft
100	1.29	10.04	8.04	.69	23.72	11.68	.725	.760	19.80
90	1.62	7.99	6.47	.84	19.49	9.98	.620	.610	15.90
80	2.09	6.19	5.07	1.08	15.16	7.85	.487	.475	12.40
70	2.75	4.71	3.93	1.42	11.52	6.03	.375	.360	9.40
60	3.70	3.50	2.98	2.01	8.14	4.12	.256	.263	6.86
50	5.20	2.49	2.16	2.90	5.64	2.82	.175	.180	4.70
40	7.94	1.63	1.45	4.44	3.68	1.87	.116	.114	2.98
30	13.00	1.00	.92	7.95	2.06	.98	.061	.062	1.62

TABLE IV.

Wire, No. 19 B.W.G
Weight = .034 lb.
Mean diam. = .040 in.
Mean h = 2.138 ft.
Iw = .0048.
Io = 2.484 + .004 = 2.488.
I = 2.484 + .004 + .005 = 2.493.

Mi. hr	N	dto	Po ho	dt	Ph	Obs. net Ph mean h	Obs. net Ph at 2.0 ft	True net Ph at 2 ft	True P per ft	True P per sq ft
100	655	1.64	7.95	1.29	10.12	2.17	2.03	2.04	.128	38.40
90	589	2.10	6.21	1.66	7.86	1.65	1.54	1.51	.094	28.20
80	524	2.67	4.98	2.17	6.01	1.13	1.06	1.06	.066	19.80
70	459	3.46	3.77	2.89	4.55	.78	.73	.72	.045	13.50
60	393	4.60	2.83	3.92	3.33	.50	.47	.46	.029	8.70
50	328	8.62	1.97	5.45	2.40	.43	.40	.27	.017	5.10
40	262	10.40	1.25	8.35	1.56	.31	.29	.14	.0089	2.67
30	197	17.00	.767	14.70	8.88	.12	.11	.06	.0038	1.14

seems to be also a function of V, practically impossible of determination; that is

$$P = KV^{F(d)} F(d, V)$$

This equation, even if it could be evaluated, is much too complicated and uncertain to be of much practical value. The important results of the work are shown in Figs. 6, 7, 8 and 9. To give an idea of the accuracy to be expected from the results the following details of precautions taken are given:

(1) Two successive runs were made with each wire tested, with a "Zero run" before and after these test runs, the average of the test and Zero runs being

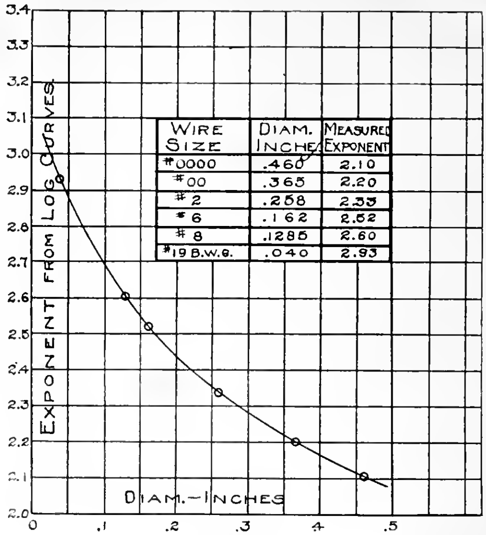


Fig. 5.

plotted. This eliminated chance of accidental errors.

(2) All journals were kept flooded with oil and as nearly as possible of constant tightness, to make certain of practically constant friction.

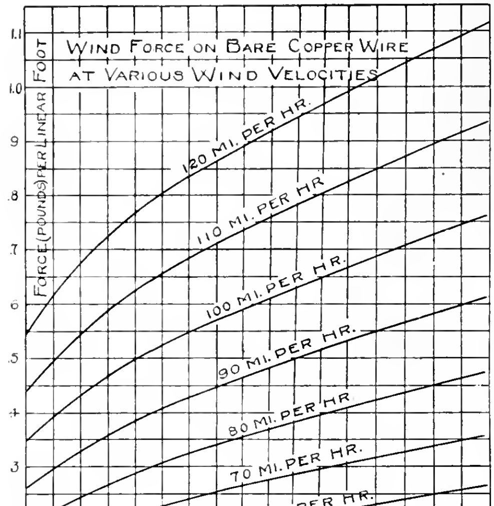


Fig. 6.

(3) The tachometer was calibrated with its pulley which was turned up to make the tachometer read correctly. The tachometer was correct at all speeds.

(4) One person made all chronograph records, in order to avoid changing the personal equation, and

to take advantage of expertness acquired in reading tachometer.

(5) It was thought that there might be some pumping effect on the air due to the wires. To determine this smoke was blown in, and also fine sawdust thrown in, while the apparatus was in rotation. From this it was found that inside the path of the wires the air had almost no motion until within one or two inches of the path of the rotating wires. From this point the velocity of the air increased rapidly towards the wires and then diminished again outside the wires. An anemometer was then placed outside the path of the wires and the wind velocity measured at various distances from the wires, for several speeds of rotation. These measurements showed that the wind velocity increased more and more rapidly as the wire was approached and seemed to show that the velocity of the air equaled that of the wire at the surface of the wire.

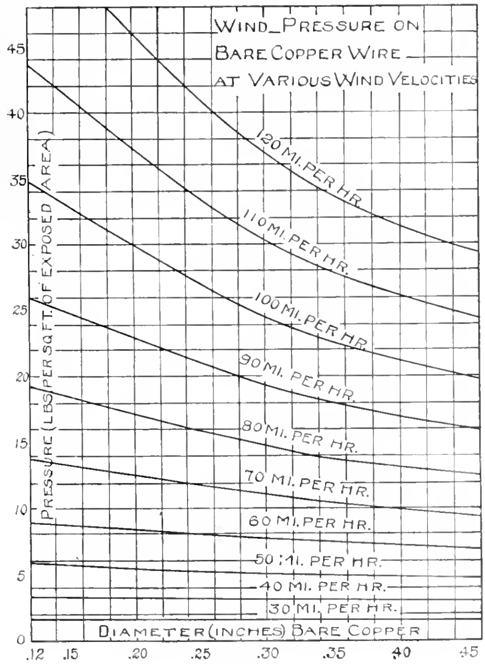


Fig. 7.

This state of affairs was to be expected, and corresponds exactly with what is called the "cushion effect" of stationary wires. In either case the relative velocity of wind and wire is probably zero at the surface of the wire, but increases very rapidly with the distance from the wire. It was assumed that the relative velocity curve for a stationary wire and moving air would be the same as that for stationary air and a moving wire, and hence no correction was attempted for this effect.

Another indication that "pumping" was not an important factor is the fact that the pressure per square foot increased with decrease of wire diameter, whereas had pumping played any important part its effect would be to show greater pressure per square foot on the larger wires.

(6) Under the influence of the normal force ($Mh\omega^2$) the wires formed approximate flat catenaries between the points of attachment of tie wires and arms, so that the distance (h) from center of shaft

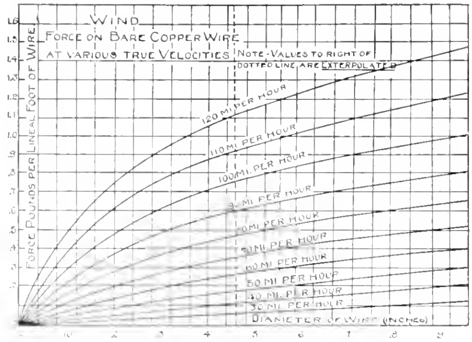


Fig. 8.

to center of wire was not exactly uniform. The wires retained this distorted form permanently, and the mean distance was computed from eighteen measurements at equidistant points along the shaft, the tie wires being meanwhile held taut. The algebraic mean of these measurements was used, and is certainly good to within 0.5 per cent or better.

(7) Since the apparatus as constructed formed a closed circuit electrically, which was rotated at high speed in the earth's magnetic field, it was considered possible, in view of the extremely low resistance of the circuit, that some energy might have been used in I^2R loss due to the induced current, thereby increasing the apparent wind effect. This effect was therefore calculated as follows:

Assumptions:

Neglect contact resistances.

Speed 800 r.p.m.

Consider No. 0000 copper in the machine.

Total intensity of earth's magnetic field .60 lines per sq. cm.

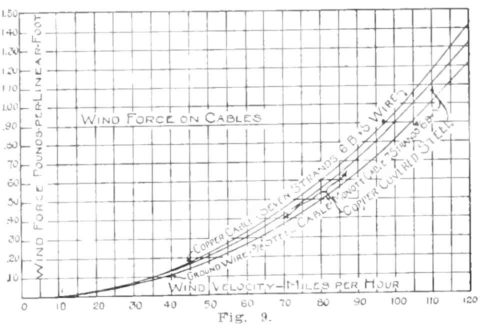


Fig. 9.

Closed circuit consisted of two wires (No. 0000) and two steel arms each 4 ft. long.

Total resistance 6.17×10^{-4} ohms.

$$I \max = \frac{(\text{Area}) \times (\text{Field Intensity}) \times \omega}{(\text{Res.}) \times 10^8}$$

$$= \frac{(4 \times 12 \times 2.54)^2 \times .6 \times 83.7}{6.17 \times 10^{-4} \times 10^8} = 12.15 \text{ Amperes.}$$

I effective = 8.59 amperes.

$\therefore I^2 R = .0456$ watts $= .0336$ ft. lbs. per sec.

This gives the total moment due to this effect of .000396 lb. ft., which is entirely negligible, the windage moment under the same conditions being about 24.0 lb. ft., as shown in the Tables III and IV.

(8) All wires tested were accurately weighed, wire tables not being used for this data. The round wires accurately fitted a wire gauge, hence tabular diameters were used. The stranded cables were measured by drawing a narrow strip of paper tightly around the circumference of the cable. The diameter corresponding to this circumference is called the mean diameter of the cable.

Results.

The results of the work are so completely expressed by the curves as to need little comment.

From the account of the precautions taken and from a scrutiny of the tables and curves the reader can form his own opinion as to the reliability of the results. In the opinion of the authors they may be depended upon to within ten per cent.

The curves show that the common assumption of a wind pressure of 20 lbs. per sq. ft. of exposed area corresponding to a wind velocity of 100 miles per hour is closely correct for No. 0000 solid copper, but that the pressure on smaller sizes is considerably greater, reaching about 35 lbs. per sq. ft. on No. 8 wire. This increase of pressure for small wires is an important result, and helps to explain the difficulties commonly experienced with telephone lines when long spans are attempted.

As can be seen by an inspection of the curves cables have from 15 to 25 per cent greater pressure per square foot than solid wires of the same mean diameter. This was of course to be expected.

In conclusion the authors desire to express their thanks to Prof. J. N. Le Conte for valuable suggestions, and to Mr. J. H. Piatt of the Great Western Power Company for suggestions and materials.

BOOK REVIEW.

Practical Applied Electricity. By David P. Moreton. Pocket size, 4½x7¼ inches ;450 pages; 273 line drawings and 50 halftones; clear type; strong paper; durable bindings. Published by Reilly & Britton Co., of Chicago, and for sale by Technical Book Shop, San Francisco. Price $2.00.

Mr. Moreton as Associate Professor of Electrical Engineering at Armour Institute of Technology, has based this text, to a certain extent, upon a series of lectures given by himself in his evening classes in the Department of Electrical Engineering at the Institute. His explanation of the fundamental principles of the subject is so clear and so simple the book is heartily commended to all those interested in teaching in the High and Manual Training Schools and can be most profitably kept as a reference book for all those engaged in the electrical trade who have been denied the privilege of university training in electrical engineering.

The convenient size and flexible covering commends its use to that great class of ambitious young men who are obliged to work many hours of the day but are ready to learn at every opportunity, even if presented while riding to and from their daily work.

Twenty pages are devoted to the index, thus making the text readily accessible for reference. As the book is just from the press it contains many new ideas and descriptions. The chapter on lighting is especially complete in this regard, giving a description of the many new lamps which have recently come into use.

Three-Phase Transmission. By William Brew, M. I. E. E. Size 5½x8½ inches; 178 pages; 82 illustrations. Published by D. Van Nostrand Company of New York, and for sale by Technical Book Shop, San Francisco. Price $2.00.

Replete with the experiences gathered while chief expert assistant, Dublin corporation electricity supply, the author shows himself thoroughly familiar with English practice. The question of higher mathematics is ignored throughout the book, working formulas being presented directly. The question of design and operation of underground cables and their consequent phenomena is discussed in much detail. The author does not show himself a master of our overhead systems in vogue on the Pacific slope. For a deeper insight into foreign practice and underground cable design, however, the book is of much value, and will add its portion toward rounding out the desk books of the modern engineer.

PROGRESS AND INTENSE INTEREST IN PANAMA CANAL.

The concrete work in the spillway of Gatun Dam is about 63 per cent completed, 141,493 cubic yards, out of a total of 225,000, having been placed at the close of work on June 24.

Interest in the completion of the Panama Canal is world-wide. From far-off Suva comes the following:

"If you glance at a map you will see," said a local enthusiast, "that Suva is on the direct line from Sydney to the canal. In fact it is exactly a quarter of the distance between Australia's commercial capital and the Pacific entrance to the canal. Supposing vessels maintaining a speed at sea of 15 knots per hour are employed, the trans-Pacific run will occupy 18½ days. Give a day for navigating the Isthmus, and 10 days on to London. This will show a saving of about a week over the present all-sea mail route to London via Colombo. Suva will be the last port of call from Sydney and the first port of call from Panama. Already land is rapidly advancing in price there, and any amount of capital is ready in Sydney to erect at Suva elaborate hotels, such as Colombo possesses. I was given to understand that the Royal Mail Steam Packet Company is already at work on plans for a first-class passenger service from Southampton to Sydney, via the Panama Canal. This corporation is simply biding its time to enter the Australian trade aagin."

THE ELECTRICAL SECTION OF THE BUREAU OF MINES, ITS PURPOSE AND SOME FRUITFUL RESULTS.

In a recent technical paper published by the Bureau of Mines announcement is made of the establishment of the electrical section of the Bureau. The following interesting features are set forth as calling for its establishment:

Electricity is used underground in mines for haulage, lighting, driving pumps, fans, drills, coal-cutting machines, and hoists, for detonating explosives, and for signaling. Both direct current and alternating current are used, the former much more extensively than the latter. Direct current is distributed at potentials up to 600 volts wherever power is used. Alternating current is distributed at over 2000 volts and is usually carried only a short distance underground to serve high-voltage motors or transformers operating motor-generator sets or rotary converters.

Electric haulage is operated principally from trolley wires at 250 or 500 volts. The trolley wire is necessarily bare, and in low coal is dangerously near the heads of persons in the same entry with it. Lighting circuits are often connected between the trolley wire and earth, with the lamps in series. Stationery motors are often connected between the trolley wire and earth. Machine wires are frequently bare up to the point of connection with the trailing cables.

Explosives are detonated from batteries (storage or primary), from magneto generators (frequently refered to as batteries), from power circuits, and from separate generators used only for detonating. Signals, which include lights, bells, and telephones, are operated principally from primary batteries.

Underground equipment is exposed to falls of roof, coal and rock, that are sufficient to wreck installations of the best character. The acid waters and the dampness in mines make the insulation problem difficult. The fact that the need of electric service at many points underground is only temporary limits economical investment in equipment. The problem of safeguarding life is rendered still more difficult by the fact that many of the underground workers do not appreciate the dangerous character of electricity and ignore the rules made for their protection. The temptation to install electrical equipment in coal mines in a temporary and improper manner is increased by the fact that coal, especially dry coal, is not a good conductor of electricity, and wires may sometimes come in contact with the coal without trouble resulting. A machine wire supported upon wooden pegs driven into the coal may never give trouble; and it would be hard to convince a man whose only experience had been with such installations that to thus support a wire is not good practice. In this connection it is probable that electrical practice in mines would be generally improved if more of the mine electricians were familiar with the best installation methods.

The three principal dangers connected with the use of electrical equipment in mines are as follows: The danger from electric shock, the danger from explosions caused by electricity, and the danger from fire started by electricity. The chief sources of danger from shock are the trolley wire and other bare conductors. Another source is ungrounded equipment that has become charged with electricity through defective insulation or otherwise.

The danger from electrical explosions arises from the occurrence of sparks and arcs in inflammable gas or dust. Sparks of sufficient size to ignite gas may be produced when a motor is started rapidly or operated under heavy load, when a circuit carrying current is opened, or when a circuit becomes grounded. A much larger spark is required to ignite bituminous coal dust, but such dust might be ignited by the opening of a circuit carrying a large current, or by flashes produced by heavy short circuits. The fall of a trolley wire might give both of these conditions. The danger from fire arises from grounds to coal or in the vicinity of inflammable material, from the flashing of motors under the latter condition, from short circuits, and the burning off of wires carrying heavy currents. Besides the above-mentioned dangers, the handling of explosives in the vicinity of electricity and the detonation of them by electric means give rise to others.

The practical solution of the problem of safeguarding the use of electricity in mines will require the adoption of protective measures and of devices that are simple, rugged, "fool proof," and as inexpensive as possible. At the same time both measures and devices must be entirely effective or they will become a menace. Although it will be necessary to investigate many possible causes of electrical dangers, some are already well known, and the desirability of protection against them is apparent.

There is a field for devices for reducing the danger of shock from the trolley wire and for devices for preventing the ignition of gas by motors, switches, and other circuit-opening apparatus. There is a field for an acid-proof material for insulating wires and cables, and there is room for improvement in the methods of installing electrical equipment underground. The improvement of electrical conditions underground will doubtless be a gradual development, as has been the case aboveground, where advancement in electrical practice has been continuous for many years.

Most mine operators, if not all of them, would be willing to install safer electrical equipment if the market could supply it. Manufacturers are willing to develop especially safeguarded equipment as fast as they see a field for its use. Some of the manufacturers of this country are now developing motors and switches designed to be explosion proof, and the Bureau of Mines has always found manufacturers of electrical apparatus ready to co-operate in its electrical investigations.

The bureau has made a few preliminary investigations, the most important of which are an investigation as to the danger of gas ignition by the indicators of inclosed fuses, and an investigation as to the danger of gas ignition by incandescent lamps when broken in gaseous atmospheres. The former is reported in detail in this circular; the latter is being continued, and a final report will be made after the completion of more elaborate tests.

Incandescent Lamp Tests.

The preliminary investigation showed that certain sizes of incandescent lamps, when broken, ignite surrounding explosive mixtures of gas and air. The tests now under way will determine the factor of safety of such lamps as have not caused ignition in previous experiments.

In making tests of incandescent lamps they are placed in a gas-tight receptacle filled with a mixture of gas and air combined in proportions most sensitive to ignition. The lamps are lighted and the filaments are brought into contact with the gaseous mixture in three ways, as follows:

(a) By smashing the bulbs completely, which brings the mixture in contact with broken filaments.

(b) By snipping off the tips, which usually does not break the filaments as the velocity of the entering gas is less than in (a).

(c) By puncturing a small hole in the necks of the bulbs, which prevents the entering gas from impinging directly upon the filaments and therefore rarely breaks them.

Such lamps as do not ignite the mixtures under normal conditions are further tested by increasing the temperature of their filaments until explosion follows the breaking of the lamps. A comparison of the excess energy required in any case gives a good indication of the relative safety of the lamp.

In addition to making these lamp tests, the bureau is investigating explosion-proof motors, explosion-proof switches, and the action of mine water upon the insulation of electric conductors.

Tests of Explosion-Proof Apparatus.

Explosion-proof switches and explosion-proof motors are tested in the same way, as the flame-proof quality of the casings is in each case the point at issue.

The term "explosion-proof," as applied by the Bureau of Mines to electrical equipment, refers to apparatus inclosed in casings that are so designed and constructed that the products of explosion resulting from the ignition, within the casing, of any mixture of methane and air will be either entirely confined within the casing or so discharged from it that they can not ignite a mixture of methane and air, combined in proportions most sensitive to ignition, entirely surrounding the casing and in intimate contact therewith.

In testing explosion-proof apparatus the casings are completely filled with various mixtures of gas and air and completely surrounded by a mixture of the same constituents combined in proportions most sensitive to ignition. The mixture within the casing is exploded by an electric spark, and the character and extent of the discharged flames, and their action upon the surrounding gas are noted.

Means are provided for measuring the pressure developed within the casings by the explosions.

Tests of Insulation of Electrical Conductors.

The present investigation of the action of acid mine waters upon the insulation of electrical conductors is preliminary in character, having for its purpose the standardization of methods for future tests. The results of this investigation will determine the character of the waters to be used, the best way to apply them to the insulation, and the most satisfactory methods of observing the action of the water upon the material under test.

In the present test two kinds of water are being used. These are being applied in three different ways to three different kinds of insulations, of each of which there are 10 samples 50 feet in length. The action of the water upon the insulation is being observed by means of insulation resistance measurements and by high potential tests.

Other Investigations.

Preparations are now being made to investigate the action of electric sparks and arcs in coal dust.

Among other investigations to be undertaken as soon as possible are an investigation of the danger of using electricity in the vicinity of explosives, an investigation of electrical shot-firing devices, and a study of devices for the protection of the trolley wire.

Tests of Inclosed Cartridge Fuses in Explosive Gas.

As a part of the investigation of the causes of mine explosions, authorized by Congress in May, 1908, the Secretary of the Interior decided that a careful examination should be made of the various inclosed electric fuses used in mining operations with a view to determining how far these fuses, when installed for service in gaseous atmospheres, might be responsible for the occurrence of disasters.

The fuses tested were standard N. E. C. cartridge fuses of the indicator type, varying in size from 30 amperes, 250 volts, to 100 amperes, 600 volts.

There are two elements of danger attending the action of such fuses in the presence of inflammable mixtures of gas and air, namely: (a) The action of the indicators located on the external surface of the shell: these when the fuse acts may, by giving out sparks or otherwise, ignite the explosive mixture; (b) the blowing of hot gas and jets of flame through the relief ports of the fuses by the energy released within the shell.

The results of the tests are summarized in the following table:

RESULTS OF TESTS OF INCLOSED CARTRIDGE FUSES.

Brand No.	No. of tests	No. of explosions	Cause of explosion. Undetermined	Indicator	Blowing at port	Percentages of explosions
1	24	10	1	3	6	41.6
2	23	12		12	..	52.2
3	32	24	..	24	..	75.0
4	24	5	.	5	..	20.8
5	20	13	..	13	..	65.0
6	21	1	..	..	1	4.75
7	32	1	..	1	..	3.125

Conclusions.

The conclusions obtained from the results of these tests are as follows:

1. One or more sizes of all the brands of fuses tested ignited the gas, although in varying degrees. Two brands ignited the gas but once; three brands ignited it in more than 50 per cent of the trials.

2. The principal source of danger in fuses as they are now designed is the device for indicating whether or not a fuse has acted.

3. Danger from blowing at the relief ports will probably develop in some and possibly in all brands if tested with enough generating capacity.

AN OPTICAL ILLUSION IN ENGINEERING.

BY ROBERT SIBLEY.

As a recompense for the hardships endured by the engineer as he enters an unexplored field, in his lighter moments there arise many strange and interesting natural phenomena for thoughtful and philosophic consideration. As he wearily packs his transit across the desert the phenomena incident to a mirage afford him constant diversion from the effects of the heat. In the high mountains the ever unfolding beauties of exquisite scenery repay him many times for his severe climb, or should his duty lead him into the heart of our great forests, the variety of foliage, the scent of the fragrant wild rose and the sparkling clear waters are a constant source of delight.

To layman and engineer alike, occur one interesting optical illusion, which has ever varying explanations given to it. Everyone of us has noted it from time to time as we have followed with our eye the winding course of the newly-constructed hillside ditch. I say "newly-constructed" for the phenomenon is more easily discerned in the early life of a ditch, the contrast between the newly deposited earth and the old making its outline the clearer. As we follow the ditch outline with our eye the ditch in its course up a gully jumps down into it only to be seen on the other side laboriously climbing again to attain what it has lost.

So deceptive appeared this phenomenon in one instance after I had carefully located a ditch in Western Montana, my Irish foreman strenuously objected to going ahead with the construction. "Why, soir," said he, "thè watter will niver run up there." As old Tom Hennessy was a very careful man, I re-checked the work unobserved to be sure that I had made no error. Meanwhile so positive was the foreman that some mistake had been made, he went to the local field manager with his complaint and finally they both brought the general manager to look at the located ditch. Upon being asked by the general manager if he had put an instrument upon the work, old Tom replied: "Why, by jabbers no, me eye tells me that, soir." Whereupon all three agreed there must be some mistake. So positive were they that I actually became alarmed myself, but notwithstanding I ordered the work to proceed and I heaved a mighty sigh of relief when upon trial the water ran across the "up-hill" part as smoothly and evenly as could be desired.

After such an experience as this I have given the matter of an explanation of the phenomenon considerable thought. Before giving my views I will first cite another illustration. Take two lines of exactly the same length as A B and C D, in Fig 1. Add the diagonal lines emanating from A, B, C and D as shown in Fig. 2, and now look at your figure. How small C D looks compared with A B. Professor Ladd in his book on Psychology explains this phenomenon as being due to the strain upon the eye in following convergent and divergent lines, the eye in following the path of least strain conceives A B as being much longer than the C D, for it is much easier to follow the convergent lines from A and B than the lines making an angle of amost 120 degrees at points C and D with outward direction from C and D, hence the optical illusion that A B appears longer than C D.

A similar explanation easily follows in observing a ditch location. The eye is accustomed to observing the horizon and this is used as our datum plane. Unconsciously we think of the horizon as being a level plane, and it naturally follows that we think of the ground around us as being level. So it is as we look up a gorge, we think of the bottom of the gorge as being level while in reality it may have a rapid fall to it. Consequently as we follow the ditch or flume on one side it apparently verily jumps down into the gorge and on the other side it laboriously crawls up again to regain its fallen supremacy. Hence follows the glowing report of the eastern visitor after having observed some of our western hydraulic enterprises that "water runs up hill in the west."

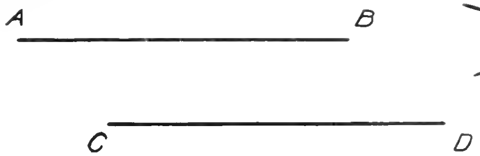


Fig. 1

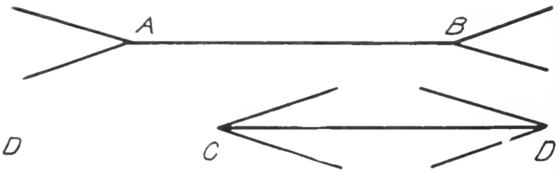


Fig. 2.

ELECTRIFICATION COSTS.

The following data are given by W. S. Murray in a paper before the American Institute of Electrical Engineers: Power houses can be constructed, depending upon the capacity, from $90 to $110 a kilowatt; line construction for one, two, four and six tracks can be erected at costs varying respectively from $4000 to $7000; from $8000 to $15,000; from $25,000 to $40,000; $40,000 to $60,000 a mile; the fluctuation in cost for these respective constructions depending entirely upon the standards elected, which are inclusive of the consideration of importance of track, in turn bringing into consideration the advisability of wood and steel and steel post construction, cross catenary and bridge span construction, single or compound catenaries, etc., also the cost of overhead yard construction can vary from $1500 to $3000 a mile, depending upon the number of tracks spanned and type of construction selected. Locomotives of the passenger road and switching type, depending upon the nature of their service, can vary in cost from $25,000 to $45,000 a unit.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Photographs illustrating the California Contractors' Camp in this issue were furnished through the courtesy of the Panama-Pacific Photo Co.

Echoes of the Coronation

Our British cousins have now completed in every detail their spectacular and time honored coronation ceremonies. The guests, whether invited or uninvited, went to look on and now for the most part, have departed on their separate ways. Engineers of America feel proud of their country's official representative at the ceremonies. Mr. Hammond, who is one of our most distinguished engineers, performed his part at the ceremonies in admirable style. Engineers the country over read with delight the fanciful accounts of this knight of the camps of years ago, transferred from high-legged boots and uniform of the miners' life to the knee breeches of the Court of St. James.

Now that the hurly-burly is passed, a time for serious reflection has come for everyone as the features connected with the gigantic ceremonies of the coronation are reviewed in mind. It is perhaps truthfully said that the event surpasses all spectacular gatherings of the ages. This spectacular effect was not only brought about by the richness of the apparel worn by all participating, but by the gigantic illuminating effects, eclipsing in their dazzling beauty and in the magnitude of the undertaking all previous attempts, and adds another mile-stone of accomplishment to the record of the electrical engineer. It is estimated that in the coronation illumination in London and suburbs between 2,500,000 and 3,000,000 electric lamps were utilized. Not one single case of fused wire has been reported. All honor to our brother engineers across the ocean.

Electrical Section Bureau of Mines

The Bureau of Mines has just announced by Bulletin, the formation, the equipment and purpose of the electrical section of the Bureau. Elsewhere in this issue will be found a detailed account of this announcement. Briefly, its purpose is to endeavor to solve the problem of safe-guarding life and property from the dangers which attend the use of electricity underground, the principal dangers being from electric shock, explosions caused by electricity and fires started by electricity. Naturally follows the final purpose which is to solve the problem of safeguarding the use of electricity in mines. This can be brought about only by the adoption of protective measures and devices that are simple, rugged, "fool proof" and as inexpensive as possible.

This new undertaking on the part of the Bureau of Mines comes at an opportune time in Western development. Coming at a period when renewed interest in mining is evident on all sides, the results of the labors of the electrical section of the Bureau will be watched with intense interest. At no time in the development of the mining industry has the demand for electric energy been greater than at present. This is instanced by the fact that a prominent feature of the expert's report on the outlook for either prospect or mine is usually given over to possibilities of nearby purchase of electric power or economic development of the same.

But little at present is known as to methods of preventing mine disaster due to the more complicated electrical causes. It is usually during the early stages of its use in mines that accidents most frequently occur. If the mine is still in a non-dividend paying condition, the management as a rule cannot well afford the time and money to be spent in a study of prevention of disaster, although most mining superintendents would gladly install equipment for preventing disaster of this sort if the same could be reasonably purchased.

One of the best results to be anticipated is the compilation for distribution of simple, plainly written literature on the subject. This will enable the prospector or the miner who usually has, from years of toil observed much natural geology and mineralogy, but little in affairs electrical, to properly protect himself. For after all it will undoubtedly be found that disaster from the use of the simple electrical apparatus used underground, as a rule, follows from ignorance of the fundamental laws of electricity.

Depreciation

The question of arriving at the proper factors of depreciation in any particular plant in the public service corporation is one of delicate determination and one which necessitates the weighing of many points involving largely the mature judgment of the expert. Similar to all other questions concerned with the uncertainties of life, the theory of probability must to a large extent enter into the choice of the particular factors of depreciation to be used. The mortality or life tables used in the insurance companies furnish an excellent example how applicable such theories are in practice when the point under consideration appears hundreds and hundreds of times so that average values can be used.

Since large numbers of similar parts are necessary in order to use current theories of probability, the property to be evaluated must have been in use for such sufficient period of time as will make the annual expenses for maintenance and repair practically uniform. It is evident also that the greater the number of similar parts contained in the property to be evaluated, the more nearly will the theory of probability apply. Hence it is true that in ascertaining the depreciation of rolling stock of a similar make in a manufacturing establishment, cross ties of a railroad, or transmission poles and cross-arms of a transmission line, it is possible to theorize with considerable exactness. In considering electrical properties, the generating units are generally few in number, consequently our theory cannot be made to apply with exactness. In a property involving, however, a large number of similar parts a very convenient method has been deduced from theory. It is the so-called "50 per cent method" and has been used by many eminent experts in evaluating public service corporations. The rule is to ascertain 50 per cent of the cost less salvage. This immediately gives the amount to be written off as depreciation.

In electrical properties as stated above, many of the parts do not appear in large numbers so that the 50 per cent method cannot be used. In considering depreciation of a single unit much depends on the point of view to be taken in arriving at a value. Those who have been so fortunate, or unfortunate, as to own an automobile know that the day after the machine has been purchased, it cannot as a rule, be sold for anything like its purchase price, yet the machine is practically as good as new and for service will probably last as long as a new one. So far then as its value to the user is concerned, it has depreciated only in such amount as would be necessary to replace the simple minor ill-effects acquired during its short usage. Unquestionably the value as a usable property should be the proper value to be arrived at. Henry Floy, the noted evaluation expert, in his paper on depreciation, presented before the recent Chicago convention of the American Institute of Electrical Engineers, went into the various factors entering into the determination of depreciation of electrical properties in a scholarly manner. Mr. Floy gives a list of constants used in assuming depreciation per year and quotes a number of cases in which these constants were used, stating the authority of each. In some cases authorities differ widely. For instance, the Wisconsin Public Service Commission claims that for arc lamps four to five per cent per annum should be allowed as depreciation, but a Board of Arbitration at Atlanta, Georgia, claims that 15 per cent should be allowed. Again in considering the depreciation of generators, the Traction Valley Commission claims 3 to 8 per cent, B. J. Arnold 5 per cent, Henry Floy 5 per cent, Wisconsin Public Service Commission 6 2/3 per cent, Arbitrators 10 per cent, and the St. Louis Public Service Commission 6 2/3 per cent. No information is given as to how these constants were arrived at by the several authorities quoted. Undoubtedly they are largely empirical, the authority in question taking all elements into consideration, after a personal inspection of the apparatus. It is apparent that the constants must be used with much care by the profession at large. Personal inspection of the plant management and its general make-up is of the utmost importance in determining whether a low factor or a high factor should be used. Years ago Ganguillet and Kutter published to the world their celebrated empirical formula for calculation of flow of water in ditches and canals. It will be recalled that in computing the final constants to be used much depends on the so-called coefficient of roughness of the particular ditch or canal made use of in conveying the water. There is no doubt but that in using proper constants for depreciation factor, the expert of the near future, if the expert of the present has not already done so, mentally at least, will evolve a series of coefficients of "managerial roughness" to be applied in his computation. To take our homely illustration of the automobile again, the expert will weigh in his mind the roughness of the attendant, the same as we weigh in our minds the probability of our arriving at a destination by automobile by observing the care with which the chauffeur avoids the rock in the road, the incoming cars or even the telegraph poles along the road.

This coefficient of roughness then, will be determined from the impressions the expert acquires during the personal inspection of the operating forces.

PERSONALS.

G. H. Hoxie, an electrical engineer from New York, is at San Francisco.

M. P. Waite, an electrical supply man of Los Angeles, is a San Francisco visitor.

J. B. Day, who is interested in the traction lines of Chicago, is a recent arrival at San Francisco.

Rudolph W. Van Norden has returned to San Francisco from an engineering trip through Lake county.

H. T. Van Riper, who is connected with the manufacture of electric irons, is a recent arrival at San Francisco.

Leon Bly, secretary of the Tehama Light & Power Company of Redding, was at San Francisco during the past week.

H. R. Austin, secretary to the president of the Los Angeles Gas & Electric Company, was at San Francisco during the past week.

F. A. Cressey Jr., who is interested in the management of the gas plant at Modesto, was a San Francisco visitor during the past week.

Ely Hutchinson, of the Pelton Water Wheel Company's sales force, returned to the San Francisco office during the past week from a trip to Portland.

Fred L. Webster, Pacific Coast manager of the Allis-Chalmers Company, left for Seattle last Saturday and will spend a week in visiting the Northwest branch office.

Wynn Meredith, Pacific Coast manager for Sanderson & Porter, is once more at his San Francisco office after inspecting the engineering work in progress at Victoria, B. C.

John W. Burke, one of J. G. White & Co.'s civil engineers on electric railway work, who spent some time on the Oakland & Antioch Railway project, left for New York last week.

J. P. Hermans has returned to the San Francisco office of the Colonial Agency Co., after a successful trip through Northern California in the interests of Economy and Colonial lamps.

H. A. Lardner, manager of J. G. White & Co.'s Pacific Coast branch office, spent the past week in Southern California inspecting electrical engineering work in progress at various points.

A. C. Balch and W. G. Kerckhoff, who are interested in the Pacific Light & Power Company and the San Joaquin Light & Power Corporation, have returned to Los Angeles after an Eastern trip.

H. C. Goldrick, manager of the Pacific Coast branch of the Kellogg Switchboard and Supply Company of Chicago, has returned to his San Francisco office from Portland, where he secured a good contract.

F. W. Mahl, formerly a local mechanical engineer, who was at San Francisco during the past week, is now assistant director of maintenance and operation of the Southern Pacific Company under Julius Krutschnitt

President D. A. Chappell of the Nevada-California Power Company, is expected to arrive at San Francisco from Denver within a few days, accompanied by C. O. Poole, of Manifold & Poole, the company's engineers.

Harry Hartwell, of Sanderson & Porter's engineering staff, recently went to Victoria, B. C., where he will remain two months in connection with a contract on the municipal water works before returning to New York.

The new executive committee of the San Francisco Section of the A. I. E. E., is composed of the following: W. A. Holabird, H. W. Crozier, F. F. Barbour, S. B. Charters and H. A. Laidner. As it is usual to start the new year with some sort of entertainment, speculation is rife among the local members as to what the executive committee have up their sleeve.

The convention of the National Electrical Contract Association ended with the election of M. L. Barnes of Troy, N. Y., as president. The 1912 convention will be held in Denver.

Gregg Curtin, Pacific Coast manager of the International Electric Protection Company of New York is a visitor in San Francisco. The company has just completed a thoroughly modern and efficient installation of their system at the Presidio and most satisfactory tests were put through during the past week.

Harry A. Mitchell, formerly auditor of the Central California Traction Company, has been made superintendent to succeed S. L. Naphtaly, who recently became general superintendent of the Great Western Power Company. The offices of the Traction Company and of the Sacramento Valley Power Company have been removed to Room 702 Shreve Building.

H. W. Jackson, assistant general manager of the Sierra and San Francisco Power Company, recently visited the hydroelectric plant at Vallecito in connection with the starting of actual work on their second impounding dam on the Stanislaus River. A moderate force of men will be employed by the company on construction this season, under the engineering supervision of Ford, Bacon & Davis. The new dam will be below and of about the same size as the "relief" dam and about 60 miles above the power station.

Dr. Frederick G. Cottrell, assistant professor in the department of physical chemistry in the University of California at Berkeley, has sent in his resignation, in order to accept a position with the United States government as physical chemist in the Bureau of Mines. Cottrell is the inventor of an electrical smoke-condenser for smelters and has done much to solve the problem of removing injurious acid fumes from smelter smoke. He also invented a process for removing the water from crude petroleum in tanks or reservoirs.

George Pancoast, mechanical engineer for the Hearst newspapers, is at San Francisco, superintending the installation of a number of large presses and other machinery of the plant of the Daily Examiner, in the new twelve-story building on Stevenson street, near Third. The first papers will be printed in the new pressroom on the 29th of July. Each of the seventy machines of all kinds will have an individual direct-connected motor. The five big presses, which require variable speeds, will be driven by d.c. motors, the Koehler, Janney and General Electric systems of control being used. A.c. motors are used with those machines which require constant speed. The new five-roll press will be capable of printing 72,000 twelve-page or 50,000 twenty-page papers an hour. All of the a.c. motors were purchased from the General Electric Company.

ANNUAL "JOLLYUP" BASEBALL GAME.

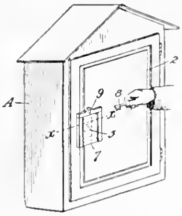
Great interest was shown in electrical circles in the baseball game on the St. Ignatius diamond last Saturday between two teams composed of the hiyu-muck-a-mucks of the Pacific Gas & Electric Company and the San Francisco Gas & Electric Company. The score was 19 to 8 in favor of the Pacifics, showing that there is some advantage in being with the holding company. Chief of Police "Gus" White was available to prevent possible hostilities. The teams lined up as follows:

San Francisco—F. H. Varney, third base; F. E. Oldis, left field; H. Bostwick, shortstop; G. C. Holberton, right field; Gus White, first base; H. P. Pitts, center field; E. E. Keppleman, catcher; A. R. Thompson, second base; J. D. Butler, pitcher.

R. J. Cantrell, third base; J. H. Wise, left field; C. J. Wilson, shortstop; P. M. Downing, catcher; E. B. Henley, center field; L J. Newbert, first base; A. H. Caine, right field and pitcher; S. J. Lisberger, second base; Charles Lusk, pitcher.

PATENTS

998,493. Lock for Fire-Alarm Boxes. Anton Glock, San Francisco, Cal. Filed Sept. 13, 1910. Serial No. 581,825. The combination with a fire alarm box and the door thereof, said door having a pocket with a glass plate forming a guard to the interior of the pocket, of a lock casing secured inside the door, a latch bolt mounted in the casing, a permanent key

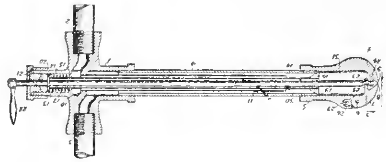


carried by the door at one side of the center thereof, said latch bolt having projections from each side of its center, one of said projections extending into the range of action of the permanent key, and a removable key insertible into the casing at the other side of the center of said latch bolt and adapted to engage the other extension thereof whereby the bolt may be operated independently of the permanent key.

998,076. Pump for Oil Wells. Daniel Daniels. Los Angeles, Cal. Filed Aug. 22, 1908. Serial No. 451,102. In a pump for oil wells, a casing having its ends externally screw-threaded, a coupling screwed upon each end of said casing, and a lining within the casing consisting of a plurality of liner sections, each section having at each end a portion of

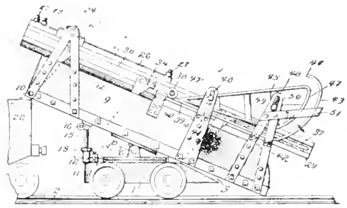
reduced exterior diameter with a smooth exterior surface, and such portion being provided with a shoulder, and a band fitting upon the reduced portions of adjacent ends of the sections at each joint between the respective sections, thereby holding the sections in alinement, the sections being supported in position within the casing by their engagement with the counterbored portion and shoulders of the couplings.

997,981. Oil Burner. Milton A. Fesler, San Francisco, Cal. Filed Nov. 2, 1909. Serial No. 525,881. In an oil burner, the combination of a steam conduit, an oil conduit within the steam conduit, discharging into one end thereof, a valve tube within the oil conduit and projecting beyond said oil conduit to the end of the steam conduit, a valve on said tube adapted to close the end of the steam conduit, a guide for said tube, a coiled spring around said tube, and a device secured upon the end of said tube against which said coiled



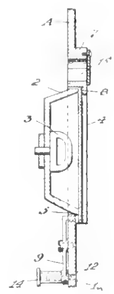
spring presses to close said valve against the end of the steam conduit, substantially as described.

998,378. Loading Device. Isaac Newton Myers, Los Angeles, Cal. Filed Aug. 17, 1909. Serial No. 513,221. A pivoted steam chest or cylinder, guide ways upon the sides of the cylinder, slides carried by the guides, shovel members



carried by the slides and depending therefrom, means upon the slides for preventing the swinging of the shovels in one direction, means for tilting the cylinder to elevate the slides and shovels, means for lowering the slides and for returning the slides and shovels to their initial position.

998,494. Guard for Fire-Alarm-Box-Door Keys. Anton Glock, San Francisco, Cal. Filed Sept. 13, 1910. Serial No. 581,826. The combination with a fire alarm box, of a suitable pocket formed therein and housing a key, a casing formed on the outside of the door and around the pocket, said casing being opened from below, a glass plate closing



said pocket and inserted into the casing from below, into a pivoted latch acting on the bottom edge of the glass plate for supporting said plate against gravity and to hold the plate in place, said latch adapted to swing in a plane parallel with the face of the glass and to a point beyond the plane of the vertical edge thereof.

INDUSTRIAL

SHUNTING VERSUS BRIDGING OF RAILWAY MOTORS.

Railway Engineering.

By referring to Fig. 1, which shows a schematic diagram for a typical Westinghouse type HL control equipment, the details of the K type arrangement may be more readily understood. With the controller on the fifth notch, which is the full series position, the current comes from the trolley through switches LS, R1 and R3, then divides through Nos. 1 and 3 motors, next goes through switch S, and finally divides through Nos. 2 and 4 motors to ground.

When the controller handle is moved toward the sixth notch, switch R1 first drops out. Current then enters through switch R2, part of it going to the motors through

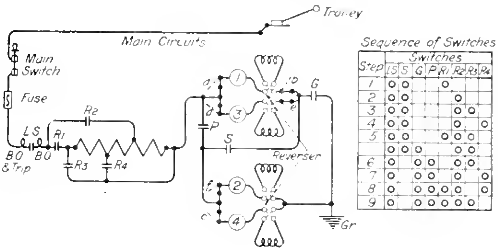


Fig. 1.

one section of the resistance and the remainder through the other section and through switch R3, after which its path is as before. The result, therefore, has been to insert resistance in the circuit.

As the handle is moved further, switch G next closes, This allows the current to go direct to ground, after dividing through Nos. 1 and 3 motors, without passing through Nos. 2 and 4; that is, this short-circuits Nos. 2 and 4 motors.

As the handle is moved still further, switch S then opens cutting off Nos. 2 and 4 motors from the series connection and switch P closes, connecting them in parallel with Nos.

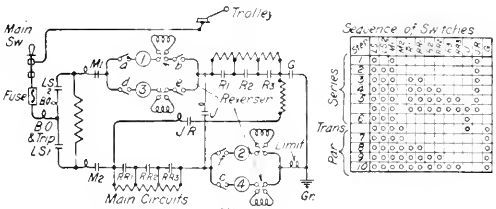


Fig. 2.

1 and 3. The change to parallel is then complete. It will thus be seen, that this sequence of changes (which, although requiring many words to describe, takes place in a small fraction of a second) maintains a current, whose value depends on the design of the resistance, through Nos. 1 and 3 motors during the entire time and thus maintains the speed of the car, instead of allowing it to fall off, as with the L type connection.

The shutting off of power from even one-half of the motors while changing from series to parallel, can be avoided and current maintained in all of them, if desired, by the use of the somewhat more complicated arrangement of circuits shown in Fig. 2. With this arrangement, in the series position, current flows from the trolley through switches LS2 and M1, divides through Nos. 1 and 3 motors, passes through switch J, and thn divides through Nos. 2 and 4 motors to ground. In changing to parallel, switches M2 and G are first closed, giving a second path for current from the trolley through the switches LS1 and M2 through the first set of resistance, through switch J in opposite direction to the motor current, through the second set of resistance and finally through switch G to ground. Switch J is then opened, leaving the motors connected in parallel instead of in series and with the first set of resistance in circuit with Nos. 2 and 4, and the second set in circuit with Nos. 1 and 3. It will thus be seen that the change has been made without interrupting the current to any of the motors.

This arrangement is called the "bridging connection." It was first put out with the automatic type of unit switch control and more recently it is used in some of the latter types of controllers such as K-34, etc.

Comparing the three general schemes of changing from series to parallel, the obvious advantages of the K type over the L type are obtained with no additional switches and no added complication of circuits, so that the perfection of the former method leaves no logical reason for any further use of the latter. The much less important advantages of the bridging connection over the K type, however, can be obtained only at the cost of a considerable number of additional switches to give the same number of controller notches as well as greater complication of the circuits. For instance, to obtain the same number of notches with the bridging connection as are obtained in Fig. 1 with eight switches, there would be required the thirteen switches shown in Fig. 2. On this account, simplicity being so essential an element in all matters relating to railway equipments, the bridging connection cannot be regarded as superseding the K type, but merely as a refinement for application in certain particular cases.

Theoretically, the bridging connection gives smoother acceleration, but practically, the K type with a properly proportioned resistance, leaves so little to be desired in this respect that it is impossible to tell by riding on a car which form of control is employed.

For controlling large motors operated from a power system with close regulation and large capacity, the ability to maintain the load on all motors throughout the accelerating period, together with the inherent possibilities of better acceleration, makes the bridging connection preferable. Where automatic acceleration is employed also, it is somewhat easier to provide a system of interlocks to produce the particular sequence of switches required for the bridging connection than it is for the K type. For this reason, automatic unit switch control equipments, since they are usually employed with powerful motors on large third-rail systems, are, except in the very smallest sizes, designed with the bridging connection. Westinghouse type HL equipments, however, which are as a rule employed for city or interurban service, have been designed with the K type connection in order to secure that simplicity and reliability which has made them so remarkably successful and satisfactory, even in the hands of inexperienced men.

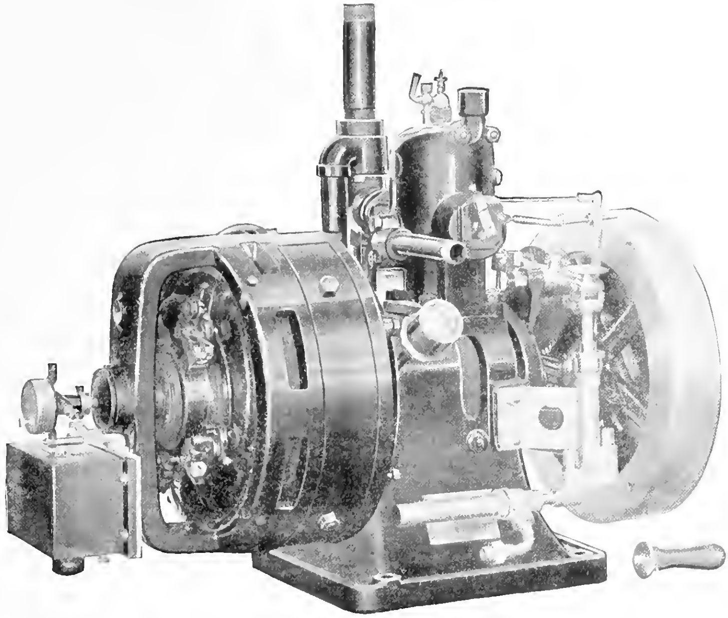
TRADE NOTE.

The Northwest Electrical Equipment Company, formerly at 530 Lumber Exchange, Portland, Oregon, manufacturers' agents, have moved to No. 7 North First street, where they have a ground floor office. Mr. Banes, formerly with the J. C. English Company, is manager of the firm.

NEW HOUSEHOLD GENERATING UNIT.

The advantages of electricity for illumination and power make it indispensable to this enlightened age, yet many people who would like to use it are not within the zone of distribution of an electrical system and so to enjoy the advantages of electricity must install their own plants.

The General Electric Company, who manufacture gasolene electric generating sets of capacities 3, 5, 10 and 25 kw. have added to this line a 1 kw. set which is designed for furnishing electricity for power and lighting in private residences, small hotels, rural railroad stations, etc., not now served by central stations, and on board boats. This set comprises a single cylinder, vertical, 2-cycle water cooled gasolene engine direct connected to a 1 kw. d.c. generator. The regulation and steadiness of the voltage of this set is so good that it is possible to supply current direct from the generator, thus avoiding the expense of installing and maintaining a large battery and the loss of power and troubles incidental to the operation of the latter.



New One Kw. Gas Electric Generator.

The engine is provided with a suction gasolene pump for lifting fuel from a tank placed under ground and located at some distance from the engine, thus fulfilling the requirements of the National Board of Fire Underwriters.

The cooling is by thermo siphon, thus doing away with the necessity of a pump to provide forced circulation of the cooling water.

The governor is located in the engine fly wheel and operates a throttle valve, giving very close regulation and satisfactory operation at all loads.

The dimensions of this 1 kw. set are: Length, 2 ft. 6⅝ in.; height, 2 ft. 2 in; and width, 17⅝ in, and the total weight is 350 lbs.

Recognizing the fact that it is frequently desirable to install a small storage battery to provide a few lights on occasions when the generating set is not running, the General Electric Company manufactures for use with these sets a suitable board for controlling both the generating set and such a battery, as well as two types of switchboard for controlling the set alone.

The combination generator and battery switchboard is so arranged that the battery can be charged at the same time that the generating set furnishes power for lights or motors, without affecting the operation of those appliances, while when the battery is fully charged it can be connected with the system so that the generating set can be shut down without interrupting the service.

NEW CATALOGUES.

A small folder, No. 4206, on Westinghouse Automatic Section Insulators, has just been sent out by the Westinghouse Electric & Mfg. Company, East Pittsburg, Pa. The folder gives the applications with style numbers, sizes of wire, and cross-section views, and will be sent to anyone interested on application.

The Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has issued Folder No. 4301, "Charging the Automobile Battery with Westinghouse-Cooper Hewitt Rectifier Outfits." The folder is well illustrated and describes outfits and accessories. It will be sent to anyone interested on application to the Westinghouse Department of Publicity, East Pittsburg, Pa.

The General Electric Company has just issued Bulletin No. 4845 containing illustrations and descriptive matter in considerable detail of its horizontal steam turbine generators of from 100 to 1000 kw. capacity at 3600 r.p.m., which is the maximum speed possible for use with 60 cycle alternating current generators. These units are particularly adapted to industrial and lighting plants requiring the economical generation of a moderate amount of power.

The engineering department of the National Electric Lamp Association have recently published two bulletins of much interest to the consumer. The bulletin on the economical operation of incandescent lamps goes into these features from the standpoint of both consumer and central station and is interesting and instructive. The second bulletin is on "Mazda" incandescent street lighting and is replete with information covering this particular phase of illumination.

NEWS NOTES

FINANCIAL.

TACOMA, WASH.—Caldwell Brothers received the contract for installing a lighting system in the court house at a cost of about $3000.

OXNARD, CAL.—The City Trustees are considering the advisability of issuing bonds for the installation of a municipal water system. It is estimated that an issue of $100,000 will cover the expense.

SAN FRANCISCO, CAL.—Stone & Webster announce that a quarterly dividend of $1.50 per share has been declared on the preferred capital stock of the Sierra Pacific Electric Company, payable August 1, 1911, to stockholders of record at the close of business, July 20, 1911.

LAS CRUCES, N. M.—The Board of Directors of the Las Cruces Electric Light & Ice Company have received a message that their bond issue of $75,000 of 6 per cent bonds has been sold. The proceeds are to be used to retire present indebtedness and to furnish additional equipment and extensions.

VALLEJO, CAL.—With the ending of the fiscal year on June 30 it has developed that the receipts for the municipal water supply of this city amounted to $78,753.99, which is an increase of close to $8000 a year over the record of a year ago. This will mean a net profit to the city of something like $60,000.

NORTH BEND, ORE.—T. B. Nolan of Omaha, Neb., has negotiated for the purchase of the Flanagan & Bennett Water Power Co., which furnishes power for North Bend. The deal is held up pending receiving a franchise. If the deal is closed the purchaser will build a new reservoir and make extensive improvements.

RANDALL, WASH.—The Valley Improvement Company of Portland, Ore., Mr. Green, manager, is getting camps established and other preliminary work in shape to begin active construction of the power plant near here. It is reported that some $15,000,000 will be spent in developing the water power and transmitting it to Portland.

LOS ANGELES, CAL.—The City Council has adopted an ordinance authorizing the issuance and sale of the power bonds in the sum of $3,500,000. They will not begin to mature until 1917. The Council will yet have to pass on the policy of selling all the bonds in the open market or selling only part of them to the city sinking fund.

SAN FRANCISCO, CAL.—The Supervisors sitting as a board of equalization, have denied the application of the Spring Valley Water Company for a reduction of several millions of dollars in its assessment. Assessor Washington Dodge filed a written statement justifying the assessment, and the board unanimously sustained his figures. The basis of the company's plea for a reduction was that the State Board of Equalization this year assessed the Spring Valley franchise under the new State revenue law, fixing its value at more than $3,600,000, and that the franchise element of the company's property, which Assessor Dodge in previous years assessed at $2,500,000, was taken into account by him this year and assessed under another name, being included in the company's personal property valuation. The company contended that it was thus being taxed twice on its franchise. Under the new State tax law the State Board of Equalization alone is authorized to assess corporate franchises. Spring Valley applied to the State Board for a reduction of its franchise assessment but was refused.

SAN FRANCISCO, CAL.—City Attorney Percy V. Long has petitioned the finance committee of the Supervisors to set aside $15,000 out of the fund of the sale of the water bonds to defray the expenses of the preparation of data in regard to the Hetch Hetchy-Lake Eleanor-Cherry Creek water site. The data is being prepared by Engineer C. E. Grunsky and is to be presented to the Board of U.S.A. Engineers now making a study of the situation for the Government.

RIVERSIDE, CAL.—The committee appointed by the Council to investigate the matter of a municipal water system for Riverside reports that the Riverside Water Company is to refund its bonded indebtedness in the sum of $750,000. It is urged that the city proceed to establish a system and is suggested that the stock of the Riverside Water Company be turned over to the city. The committee also suggests a plan by which an entirely new company may be formed at a cost of $225,000.

WOODLAND, CAL.—President Thomas T. C. Gregory of the proposed Sacramento-Woodland electric line, states that $750,000 of the million dollar bond issue of the company had been subscribed. The fund thus raised will be used in the construction of the line, work to commence within a few days and the line to be in operation before the end of the year. The balance of the bond issue, $250,000, will be floated after the road has been completed to raise a fund for the extension of the line to Winters. Of the $750,000 bonds sold, the banks of Woodland have taken $215,000, the Natomas Consolidated Company and the West Sacramento Company have taken $250,000, and the Sacramento Bank and individuals connected with that institution subscribed the balance making up the three-quarters of a million dollars of bonds floated. The bridge of the lines over the Sacramento River will be completed by September 1. All the piers are in and the steel has been placed between two of the piers. Forty-two carloads of steel have arrived to be used in the completion of the bridge. An effort is being made to have the State enter into an agreement with the new line to construct a joint grade for the railway and the State highway between Woodland and Sacramento.

INCORPORATIONS.

BRAWLEY, CAL.—The Schenck Project Water Users' Association of Holtville has been incorporated with a capital of $500,000 The directors are W. J. Seat, C. J. Schenck, M. A. Kendall.

SAN BERNARDINO, CAL.—Amended articles of incorporation of the East Redlands Water Company have been filed. The capital is $100,000. The place of business is Redlands. The original incorporators were H. L. Drew, Lewis Jacobs, H. M. Barton.

ILLUMINATION.

EUGENE, ORE.—The city water board will at once advertise for bids on furnishing poles for the city's projected lighting system.

ELLENSBURG, WASH.—This place is circulating petitions urging the immediate installment of additional cluster lights on streets.

PHOENIX, ARIZ.—A thunder storm raging above the Roosevelt storage dam recently broke the intake canal of the government electric plant which furnishes Phoenix with light and power.

ADAMS, ORE.—W. B. Salt, representing the Pacific Power & Light Company, of Portland, is considering the installation of an electric light system at this place.

BAKERSFIELD, CAL.—A movement is being agitated by local merchants looking toward the installation of an electric plant to supply the business section of the city with lights.

CONCONCULLY, WASH.—Within the next six weeks this city is to be electrically lighted, according to the statement of J. D. Morton, owner of the franchise granted by the Council.

WALLA WALLA, WASH.—The city clerk has been instructed to advertise for bids for furnishing electric power for the arc and cluster lights in the city for both five and ten-year periods.

ANAHEIM, CAL.—J. H. Ahlhorn has reported to the Board of Trade on the installation of lights for the business streets and has been appointed a committee of one to take up the matter with the business men.

CHICO, CAL.—At a recent meeting of the City Trustees the matter of an electrolier street lighting system in the business district was informally discussed. As a result the board will obtain figures on the cost of installing the system.

TRANSMISSION.

COLTON, CAL.—The Edison Electric Company is to build a new power house at M and Eleventh streets.

EUREKA, NEV.—The power plant located at Jack Creek about 21 miles from Tuscarora, Elko County, was struck by lightning last week and burned to the ground.

WEAVERVILLE, CAL.—The Trinity Dredging Company has made application to the Board of Supervisors for a franchise for a transmission line in the county of Trinity.

SANTA ROSA, CAL.—The contract for the erection of the new power house at the county farm has been formally awarded to Hoyt Bros. of this city, the lowest bidder.

LOS ANGELES, CAL.—An ordinance has been adopted granting the Pacific Light & Power Company a franchise to operate and maintain an electric pole and wire system in the County of Los Angeles.

NORTH YAKIMA, WASH.—The Pacific Power & Light Company has made application to the Commissioners of Yakima County for a franchise for a period of 50 years, authorizing the county to operate transmission lines within the County of Yakima.

EUREKA, CAL.—Sealed bids will be received by the Clerk of the Board of Supervisors at his office, in the Court House, up to August 14th, 1911, for a 50-year franchise to erect and maintain poles and string wires for transmitting electric power along the public roads in district No. 5.

BUTTE CITY, CAL.—The Northern California Power Company, which is constructing a 60,000 volt power line from Hamilton City to Princeton, is now within a short distance of Princeton. The crew is erecting about half a mile of line and poles daily. Copper and aluminum wire is being used. The sub-station has been erected on the river bank near the bridge. It is stated here that the company plans to extend its line south to Maxwell, Williams and other points, and that the plant at Williams has been taken over.

SACRAMENTO, CAL.—The Citizens' Light & Power Company has closed a contract with J. W. Hornung, representing the Great Western Power Company by which the Great Western Power Company is to furnish the local company with electricity for local consumption. George W. Peltier has been elected president and it is given out that the stock had all been subscribed. Part of the electricity will be generated at the Big Meadows plant and the remainder will be generated at a steam auxiliary plant to be erected near this city.

GOLDENDALE, WASH.—N. B. Brooks, local attorney for the Northwestern Electric Company, states that the company has advertised for bids on a $100,000 dam, to be constructed on the power site on the Big Klickitat River, between this city and Lyle. The company will also install a $500,000 electric plant at that place.

PORT ANGELES, WASH.—The Olympia Power Company has awarded the contract to P. J. Woods for constructing the right of way for a transmission line from this place to Irondale. The contract comprises clearing and furnishing cedar poles at a cost of $18,000. The company will itself erect the transmission line.

NORTH COLUMBIA, CAL.—The St. Gothard Consolidated Gold Mining Company, operating the Delhi mine, is planning to put in an electric plant. The company owns a valuable water right in Bloody Run, and it is believed that enough power can be developed to operate the Delhi mine, which has been without water the present season, owing to the damaged flumes of the Northern Water & Power Company, which have heretofore supplied water to the mine. An engineer is now on the ground making the necessary surveys.

TRANSPORTATION.

MEYERS FALLS, WASH.—The Stevens County Power & Light Company is surveying preparatory to extending its electric line to Marcus.

PORTLAND, ORE.—The Portland Railway, Light & Power Company has purchased lots in Etna addition in the vicinity of East 28th and Burnside streets as a site for a car house.

SAN BERNARDINO, CAL.—Assistant Engineer Fowler of the Pacific Electric is here with a force of eight men to take up surveys in connection with the proposed electric line extension west and southwest of San Bernardino.

SAN RAFAEL, CAL.—The Trustees have received a petition from George D. Shearer, asking that a franchise be granted him for a term of 49 years to operate an electric road over certain streets within the city limits of San Rafael.

STOCKTON, CAL.—The San Jose Electric Railway Company has commenced laying rails. Ground was broken in Modesto Friday for the 90-pound rails. There are about $1\frac{1}{4}$ miles of track to lay at Modesto.

SACRAMENTO, CAL.—Commencing next Wednesday the Central California Traction Company will tighten up its train schedule between Sacramento and Stockton, clipping 15 minutes from the schedules of all trains. Trains which now require one hour and 55 minutes to make the run will make it in one hour and 40 minutes. Additional trains will be added to the Lodi service. Sacramento trains will make better connections at Stockton with the Santa Fe to and from Fresno and San Joaquin Valley points, at Herald with Southern Pacific trains to and from Ione, Jackson, Sutter Creek and Amador County points, and at Sacramento with the Northern Electric Railway to and from Marysville, Oroville and Chico.

OAKLAND, CAL.—The precedent established by the Oakland Traction Company several weeks ago in installing a through service of coupled cars on Twelfth street to the Key Route pier, is soon to be followed up in various portions of the city, according to an announcement made to the commis-

sioners by W. R. Alberger, vice-president of the company. Alberger states that within a few days the company will install a special service from Twelfth street and Broadway to Hayward. Coupled cars will be used, and stops will be made only at San Leandro and Elmhurst. The schedule of regular car service on the line will not be curtailed. Similar changes will be made on the Oakland Traction Company lines to Richmond and Albany, in order to regain business taken away from the local concern by the Santa Fe. Alberger states that sixty new cars have been ordered. Ten cars are expected next week and twenty have already been received.

RIVERSIDE, CAL.—Officials of the Pacific Electric Railway Company are going over the Magnolia avenue extension plan. The company is ready to build a line along Colton avenue, through Colton to San Bernardino. The company will also build from here to Los Angeles.

TELEPHONES.

CAREY, IDAHO.—The Carey Telephone Company, capital $2100, has been incorporated by C. C. Shelter and Thos. C. Stanford.

LIVERMORE, CAL.—The Stockmen's Protective Association is making efforts to secure better communication with the mountain section southeast of here.

EVERETT, WASH.—The Cedarhome Telephone Company, capital $10,000, has been incorporated by Peter Hanson, H. Neilson, O. A. Prestrud and others.

NEVADA CITY, CAL.—The Tahoe national forest has let the contracts for constructing telephone lines in various parts of the forest. Work will commence immediately.

VANCOUVER, B. C.—It is announced that the British Columbia Telephone Company will shortly install a new cable connecting this place with Nanaimo, on Vancouver Island.

PENDLETON, ORE.—An effort will be made to have the city attorney to draw up an ordinance compelling telephone companies to install all telephone and electric light wires underground hereafter.

VENTURA, CAL.—The Pacific Telephone & Telegraph Company is about to commence construction of three additional trunk lines from Ventura to Santa Barbara and an extra line from Ventura to Oxnard.

WILLOWS, CAL.—The Pacific States Telephone & Telegraph Company is planning numerous improvements in the service here. It is declared that an expenditure of $15,000 will be required to carry out the plans.

CHELAN, WASH.—The Knapps Coulee Telephone Company has decided to proceed at once with the construction of the proposed rural telephone line through Knapps coulee. The trustees were instructed to purchase the necessary equipment.

MANILA, P. I.—The joint board on wireless telegraphy, appointed some time ago in the Philippines, has held its first meeting. It is understood that the report contains recommendations which will probably result in the early establishment of a wireless system in the islands.

NAPA, CAL.—The application of H. Voorman Du Bois for permission for the period of 20 years to build and maintain a telephone line near Napa, on the county road leading to Sonoma, has been granted. The line will be constructed under the supervision of Jasper Partrick, supervisor of West Napa township.

NAPA, CAL.—The application of W. H. Simmons and others for permission for the period of 20 years to build and maintain a telephone line near St. Helena has been granted. The work of constructing the telephone line will be under the direction of B. Bruck, supervisor of Hot Springs township.

WATERWORKS.

GRESHAM, ORE.—The Gladstone City Council has decided to employ H. C. Kelsey, an engineer of Portland, to draw up plans and specifications for a waterworks plant to be installed by the city. The Council has decided upon an appropriation of not more than $20,000 for the work.

SAN LUIS OBISPO, CAL.—The Pine Mountain Water Company has let a contract for a 40-mile pipe line from the Cuyama to the town of Maricopa.

WILLITS, CAL.—The Board of Trustees will take immediate steps for the acquisition or construction of a municipal water system in the town of Willits.

TACOMA, WASH.—The Council has provided for the installation of a 6 inch wooden water main in East B street from South Sixty-fourth street to South Seventy-second street.

PORTLAND, ORE.—Steps towards the installation of water meters throughout the city will be taken by the mayor at a meeting of the water board. The cost is estimated at $300,000.

TOLEDA, ORE.—Jacobson-Bade Company of Portland has been awarded the contract for the construction of the water system. Six miles of pipe will be laid and the contract was awarded for $20,000.

PRESCOTT, ARIZ.—Business men of the city have begun an effort to secure a better and less expensive water supply for the city. The Council has been asked to appropriate a sum for drilling an experimental well.

FRESNO, CAL.—The Supervisors have ordered the surveyor to draw plans and specifications for the erection of a 45 foot water tower at the alms house. An additional steel tank of 7000 gallons capacity will be erected.

GLADSTONE, ORE.—Louis C. Kelsey, has been employed by this place as engineer to prepare specifications and estimates for a pumping plant and water works system. An election to vote $20,000 bonds for construction will be held July 31st.

PHOENIX, ARIZ.—Application for a patent has been made for the new townsite of Superior. That mining camp is to have a water system. The lakes on Queen Creek above Superior have been located for the purpose and water will be piped to town for minir and domestic use.

ONTARIO, CAL.—The general water committee has recommended to the Cou l nat an extension of 200 feet of 4 inch pipe be made for ev y customer outside of the limits of the system as planned by F. E. Trask of Los Angeles. The water system for the city is now under construction.

IRVINGTON, CAL.—Through the efforts of the chamber of commerce the fire protection system of Irvington will be improved by the installation of a 75,000 gallon water tank on the hill near the Palmdale winery. A six-inch pipe will be run from the reservoir to the water main in First street.

HAYWARD, CAL.—Sealed bids will be received by the Board of Supervisors at the clerk's office up to 10 a. m. July 24th, 1911, for the construction of a water plant on the Lake Chabot road from Castro Valley road to the County road No. 2730. Plans and specifications are on file with the clerk.

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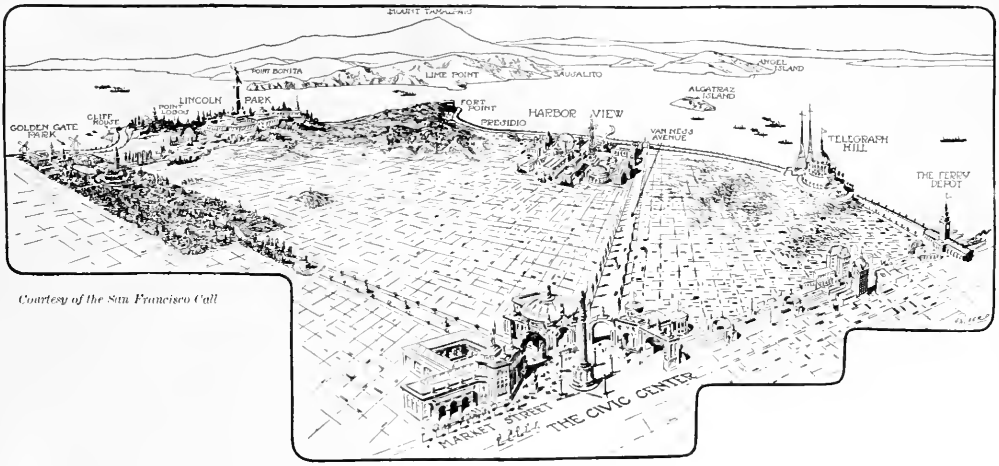


Courtesy of the San Francisco Call

Birdseye View of Panama-Pacific Exposition Site

EXPOSITION SITE TRANSPORTATION FACILITIES

On July 25th the Directors of the Panama-Pacific International Exposition Company came to a unanimous decision in the selection of a site for the great world's fair to be held at San Francisco in 1915. Briefly, the site comprises lands between Fort Mason and the Presidio, thence by ocean boulevard around the Presidio to and including Lincoln Park, adjoining Fort Miley, thence to Golden Gate Park, thus assuring ample space for all exposition purposes. This plan including parks, and running from bay to ocean, giving four miles of frontage along the Golden Gate, as C. C. Moore, President of the Exposition aptly put it, offers unlimited scenic beauties and architectural possibilities, and is particularly appropriate for the celebration of the greatest maritime event of the age in a great seaport.

As added features to the above scheme, it is planned to make use of Telegraph Hill and erect upon it the largest wireless telegraph station possible, by means of which the passage of the fleet through the canal can be continually signalled. The city park adjoining this monster monument, is to be improved with a permanent observatory and the sides of the hill beautifully terraced.

To finally cap the entire plan, a civic center with its convention hall and opera house, is planned for the heart of San Francisco, and it is suggested to locate the center near Van Ness avenue and Market street.

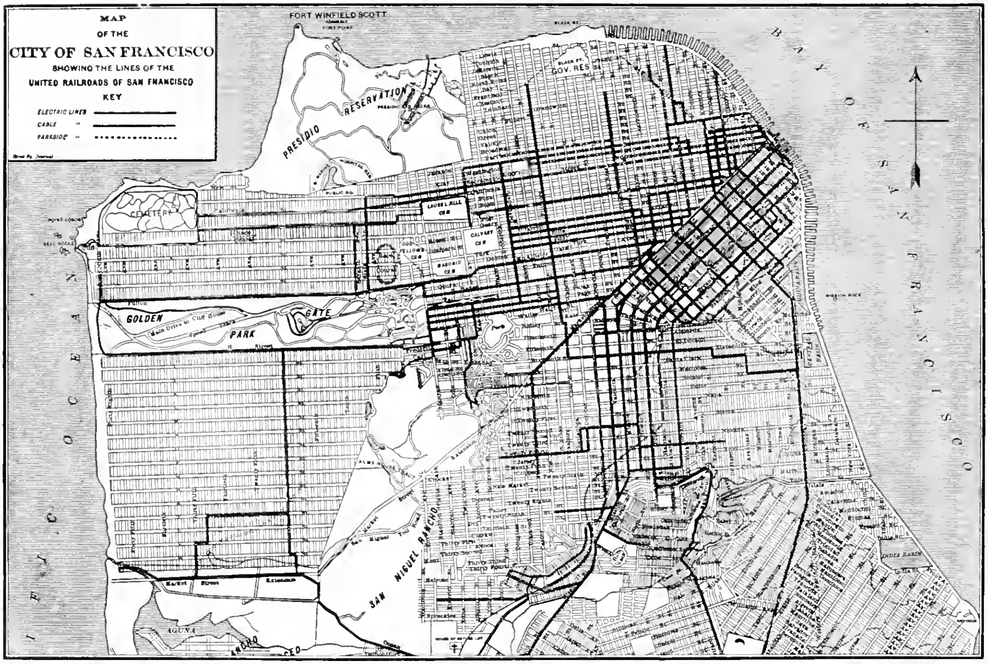
In reviewing this clever inspiration of the committee approval is voiced on all sides: The permanent buildings in the parks, the beautification of the parks themselves; the wonderful marine boulevard, and the suggested civic center—surely a city never had such a vision before in immediate prospect of realization.

As to the financial outlook $7,500,000 have been raised by subscription; $5,000,000 voted in city bonds; $5,000,000 raised by State tax; and many more millions will be contributed by the counties of California in their exhibit taxes. With this huge sum in view from home enterprise it is anticipated that an equal amount will be contributed by foreign countries and other States of the union. A contribution of $5,000,000 is confidently looked to from the national government

for building such buildings as may afterward be turned over for permanent barracks at the Presidio. This is in addition to the $10,000,000 available in the way of harbor bonds. Hence $50,000,000 is put as the amount that will be available as a financial enterprise.

John Barrett, Director-General of the Pan-American Union, has recently come to San Francisco after representing President Taft at the ground-breaking ceremonies of the San Diego Exposition, and aptly expressed a few words of comment as follows:

"All the world is preparing to reap the commercial benefits of the Panama-Pacific canal—all except the United States.



San Francisco Street Railway Systems.

"Every other great nation has long since begun to evolve the practical problems which will arise with the readjustment of the world's commerce when the canal is opened," continued Barrett. "But the United States has done nothing. Congress has a great task before it, in the settlement of tolls, canal administration, the relation of the canal to the Canal Zone Railroad, and in fact the whole of the vast machinery necessary for operating the big ditch.

"Merchants all over the country must begin to study the canal and the effect it will have upon their business; importers and exporters must be ready with facilities and arrangements for meeting the new conditions of world commerce. Otherwise, the United States will be in the position of the man who builds a magnificent house and moves in before it is finished, before the plumbing is installed and before the glass is put in the windows.

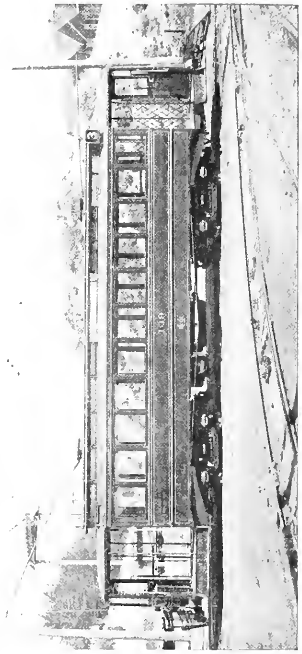
"The great Panama-Pacific Exposition should not be a celebration of the opening of the canal so much as a celebration of the fact that the United States, and particularly California, is ready for the opening and ready to reap its immense advantages. I believe that the whole question of the success of the Exposition is up to San Francisco. The world, especially foreign countries, will accept the invitation to participate, for they are fully convinced that San Francisco intends to make this the greatest Exposition the world has ever seen.

"The foreign countries can best be interested to contribute generously to the success of the Exposition by being assured that it will be a fitting celebration of what is everywhere considered the physical accomplishment of a marvelous engineering feat and the greatest single achievement in the interest of world commerce—in fact, the doing by the hand of man what God himself forgot to do in the busy creation of the earth."

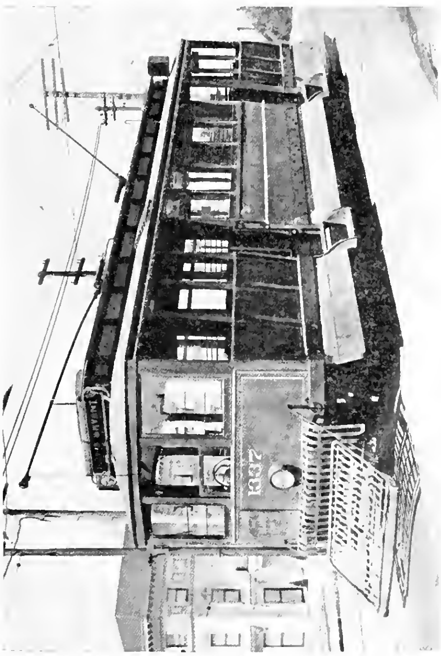
Four years of time and thought in carefully planning to handle the mammoth crowds to be expected at the great exposition is none too little to have in view. Much thought can profitably be given to every phase of transportation. The proper supply of cars and the avoidance of confusion in their handling are items of extreme importance. The proposed plan simplifies congestion to a great extent in that more car lines are available for transportation and the choice of Harbor View will give to sight-seers a ready access to the Fair grounds by ferry-boat from Oakland, Berkeley and Marin county.

It will be well at this time, however, to go into the details of the make-up of San Francisco's street railways and far in advance spread knowledge as to difficulties to be encountered and thus allow ample

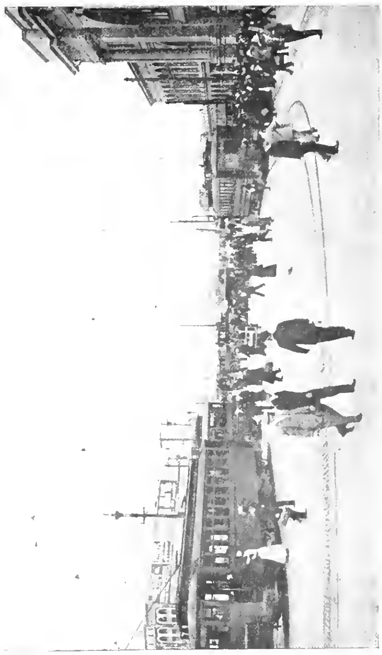
Most Crowded Center in San Francisco



New Type of P-A-Y-E Car in Use in San Francisco.



Typical California Car—Open Type



Crowded "Turn-Back" at Ferry Building.

time for the planning out of proper care for the anticipated congestion.

The T. G. Brill Company of Philadelphia have furnished many of the cars now in use in the city of San Francisco and as much valuable information has been compiled by them relative to the transportation facilities of the city, through courtesy of the company much of our information has been compiled.

It will be well at this time to look into the general geographical considerations of the exposition city. San Francisco, the largest city of the western half of the United States, is built at the upper end of a peninsula enclosing the southern part of a bay of the same name and is at the center of the long coast line of California. The city is nearly square in shape, about 7½ miles each way, with most of the streets running at right angles and the main business thoroughfare, Market street, bisecting it from the northwest corner to the southwest. The city has a population of 420,000 and the railway lines serve about 450,000. Across the bay is Oakland, with a population of 225,000 and a string of populous towns on each side and at different points on the bay, all connected with San Francisco by an extensive system of ferries and steamboat lines and contributing a large amount of traffic to the lines which converge at the Ferry Building, foot of Market street. At this point and at Third and Market streets occur the greatest congestion during the rush hours, which are from 6 to 8:30 in the morning and from 4:30 to 6:15 in the evening. The congestion is severe all along Market street through the business section, as it is the main artery of travel of the city and carries the bulk of the street car traffic. Parallel to Market and one block south is Mission street, which is next in importance as a business and traffic thoroughfare and which turns after leaving the business district and traverses the populous central section known as the Mission and continues to a short distance beyond the southern boundary line; the Mission street line extending the whole distance, about 7½ miles. Another long line, but nearer to the bay, serves this part of the city; and running to Ocean Beach, on the west side, are several long lines. The development of the outlying portions of San Francisco is therefore chiefly in these directions, and while the city belongs to the peninsular class, it will be many years before the limiting effect of the peninsula is felt, and in the meantime the development will proceed on the radiating plan.

The topography of San Francisco makes the street railway problem about as difficult as it is in any large city in the country. Generally speaking, the residence district consists of a series of hills involving very steep grades. The business section of the city lies along the bay shore and is fairly level. These lines in the majority of cases require operation on grades all the way from 27 per cent down. For this reason San Francisco was less inclined to take up electric traction than it might have been otherwise. Cable roads, in spite of their expensive operation, were generally used up to the early nineties, and suburban traffic at that time was handled with small steam locomotives. Gradually a few crosstown lines, whose grades were not heavy, were equipped with electricity and the only interurban line down the peninsular to San Mateo was built. Naturally these conditions had a marked influence on the type of rolling stock. The early cable cars consisted of two parts, the small framework, carrying the cable grip—known as the dummy—followed by a small trailer. Subsequently the dummy and trailer were combined in the same frame-work, making substantially a double-truck car. When electrical operation commenced, a car, which has since been known as the California type, was developed. This consisted, generally speaking, of a central closed portion with two open ends. In some of the cars the open ends had transverse seats, and in some the transverse seats faced outward. This car, having double trucks, was simply a growth of the original cable car idea, the climate of San Francisco being somewhat responsible for retaining the open section. During eight or nine months of the year it is sufficiently mild for outside riding, as a matter of preference, though heavy fogs and sudden chill winds require a closed portion for some of the passengers.

With the great fire of 1906, a complete rebuilding of the track within the burned area was necessary. While a gradual transition from cable to electric operation would probably have come about normally on account of the increased cost of operation of the cable road, the fire gave the opportunity for a complete change immediately. With an area of four square miles in ruins, the rebuilding was permanent and substantial. The total mileage of single track within the burned area was 60 operated by overhead trolley and 40 by cable. With the rebuilding, only two or three comparatively short lines were rehabilitated as cable lines, and these only because the grades were prohibitive from the standpoint of electric operation. The steepest grade in actual electrical operation at the present time is known as the Fillmore street hill, which is two blocks long, 27 per cent. This piece of track is operated, however, with a weight balance in addition to the trolley. There are in regular operation, without weight balance, grades several blocks long, 13 per cent, and a block each, 14 per cent and 16 per cent.

As an item of interest, while the combined electric and cable system of the city is now up-to-date and well operated, it is a peculiar fact that there is at present practically every type of traction lines actually in service, with the exception of the old steam dummy, which originally carried suburban traffic. Owing to a franchise dispute, a short section is still operated with horse cars. One short line, owing to property owners' dislike for overhead trolley, has the original cable dummy and trailer with cable operation. A few heavy grade lines are still operated with up-to-date double-truck cable cars, and the successive steps in types of traction and rolling stock are still represented up to the modern closed double-truck car arranged for fare prepayment.

With the exception of 11½ miles of cable railways of the California Street Cable Railroad, 7½ miles of the Geary Street, Park & Ocean Railroad, also cable, and 8 miles of electric lines of the Presidio & Ferries Railroad, all the street railways are operated by the United Railroads of San Francisco and consist of 261 miles electric and 14 miles cable. The United Rail-

roads has three different types of cars which might be considered standard, which are the California combination open and closed type which is operated on a number of the divisions; the cross-seat closed car, which is most prominent on the Market street and tributary lines; and the new P-A-Y-E cars, of which the first lot were put in operation five months ago on the Sutter-Jackson street and Cliff House lines, running across the northern part of the city. It is expected that there will be 80 of the latter cars in operation before the end of summer. The United Railroads system has in all approximately 600 electric motor cars and 50 cable cars. The three other railway companies together have about 100 cars.

Much forethought has been used in planning the handling of great crowds in other cities. The greatest problem to be solved in San Francisco is the question of constructing safe terminal facilities at the Fair gates which will permit a ready and safe means of transportation to and from the Fair for the thousands of visitors confidently expected. The experience gathered from similar Fairs will aid much, but after all, due to the peculiar topographic location of San Francisco new and original schemes will largely have to be contrived.

ANNUAL REPORT—COMMISSIONER OF PATENTS.

The annual report of the Commissioner of Patents, for year ended December 31, 1910, shows that the receipts of the office total over two million dollars. The applications numbered nearly 65,000; those issued, 36,000.

In more detail the report shows the total receipts were $2,025,536.69; the expenditures, $2,005,711.94, and the surplus of receipts over expenditures, $19,824.75. The total balance to the credit of the Patent Office in the Treasury of the United States on December 31, 1910, was $6,998,227.64. This is the smallest annual surplus in the Patent Office, with but one exception, for thirty-five years.

Previous to this period the salaries of the examiners had not been increased since 1848, or for a period of sixty years, which necessarily resulted in the loss, by resignation, of a large percentage each year of these highly educated and experienced men. At the present time, since the increase of salaries, the Commissioner has been able to retain a much larger percentage of these technically trained employes.

In proportion to population more patents were issued to citizens of Connecticut than to those of any other State—1 to every 1126. Next in order are the following: District of Columbia, 1 to every 1329; California, 1 to every 1616; Massachusetts, 1 to every 1623; New Jersey, 1 to every 1727.

The fewest patents granted in proportion to the number of inhabitants were in the following States and Territory: South Carolina, 1 to every 17,620; Mississippi, 1 to every 14,975; Hawaii, 1 to every 13,707; Georgia, 1 to every 12,192; North Carolina, 1 to every 12,056; Alabama, 1 to every 11,812; and Arkansas, 1 to every 11,662.

COSTS PER ACRE FOOT OF SMALL ELECTRICALLY DRIVEN PUMPING PLANTS.

BY E. C. METZ AND CLARENCE L. FRASER.

Much interest attaches to actual costs of operation in small pumping plants. Many reports of efficiencies high in value or of cheap costs of operation are rife. The data herewith presented represents average conditions, nevertheless, and it is hoped may serve its purpose in the way of creating a desire on the part of the small user to study conditions of operation and maintenance with greater care. A large field for improvement is open to the thoughtful user, as may be gleaned from the data herewith presented. Every step in the necessary calculations is put in print in this article so that anyone not versed technically can perform them on their own installation.

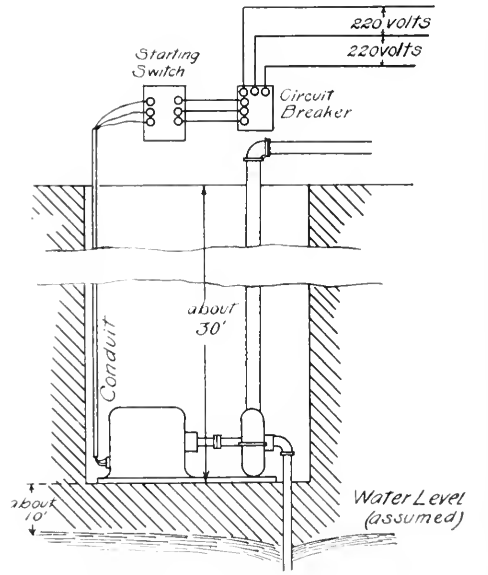


Fig. 1. Diagram Showing Motor Connections.

Irrigation by means of electrically operated pumps has only recently come into general use. The only near competitor of the electric motor is the gasoline engine. The advantages of the induction motor over other sources of power are, (1) the initial cost is low, (2) hardly any attendance is required even in pumping plants of large capacity and (3) the cost of repairs is much less.

The motors are generally direct-connected to the pumps and the combination put on one foundation, making a very small compact unit. In most cases the whole unit is put down in a shaft just above the water level. This is so the pump will have a very low suction head, generally not over fifteen feet.

The plants tested and studied in preparing this paper were situated at Exeter, Tulare County, California, and were selected with a view of getting plants that were representative of the above type in this district. Most of the water pumped is used to irrigate citrus groves, although some is used to irri-

gate orchards and vineyards. The pumping season begins in March and lasts through November. It was hoped to make the tests on these plants during the pumping season, but instead the tests were made in the early part of January. At this time the water level was probably a little higher than it would be during the pumping season.

The usual method of installing these plants is first to bore the required size of well to the necessary depth. Then a shaft about six feet square is excavated around the well to a depth of about thirty feet. The shaft is dug so the well will be in one corner. The shaft is then boarded up on the sides or curbed up with brick. The pump and motor, direct-connected, are then put in the bottom of the shaft.

The capacity of the motors vary from five horse-power to seventy horse-power but the average size of the motors is about seven and one-half horse-power. The average discharge head or lift is about thirty feet and the suction head varies from eight to fifteen feet. The starting switches, circuit-breakers and fuses are located in a small housing on the surface, so that the motor can be started without having to go down the shaft.

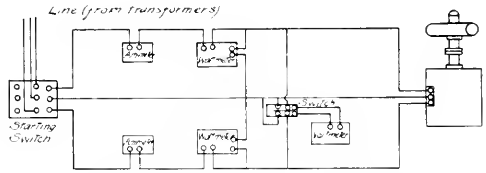


Fig. 2. Diagram Showing Connections Made in Test.

The secondary transformers that supply the power to the motors are owned by the consumers and are placed outside either on a pole or on a raised platform. The owner pays for the power loss in the transformers. The power circuits are two-phase three-wire and the power is supplied at 220 volts to the motors. Most of the plants are arranged with a double-throw switch so that when the pump is not being used the consumer has the privilege of using the power for lighting purposes. The consumer pays a flat rate of fifty dollars ($50.00) per horsepower per year, with the privilege of using the power for lighting purposes.

The tests herein recounted were made in January, 1911, and were carried out as follows. The instruments were connected in between the starting switch and the motor as shown in Fig. 2. Since the circuits are two-phase, a wattmeter and an ammeter were connected in each phase. A voltmeter switch was used and the voltage across each phase was obtained. The weir-box was set up as near the pump as practical and properly leveled.

Before any readings were taken a run of from thirty to forty minutes was made. By this time everything was running smoothly and the water seemed to be pumped down to a constant level. Readings were taken on the instruments and the hook-gauge read simultaneously. The static head remained constant throughout the test and was measured at the end of the test. The power input remained practically constant so that it was only necessary to take readings every fifteen or twenty minutes.

The instruments used in this test were two indicating 7½ kw. Weston Wattmeters, Nos. 3950 and 3026, and two Weston Ammeters, Nos. 62840 and 78025, and a Weston Voltmeter No. 6270. The wattmeters and ammeters were calibrated both before and after the tests were made. The voltmeter was calibrated after the tests were made and was found to be fairly accurate.

For measuring the water discharge a rectangular weir was made. The weir-box made of 1 inch boards was one foot deep by four feet wide by six feet long with the weir in one end. Boards were fastened in the box to check the velocity of the water. The weir was made of galvanized iron and was eighteen inches long. A hook-gauge, graduated to hundredths of feet, was placed 2½ feet back from the weir.

Four pumping plants in all were tested but the results of one test were rejected because sufficient data could not be obtained. In this paper the different plants will be known as

(1) Plant No. 1.
(2) Plant No. 2.
(3) Plant No. 3.

Plant No. 1 is owned by T. C. Ostrander and is located about one quarter of a mile east of Exeter. The pump is used to irrigate fifty acres of oranges but is large enough, according to the owner to irrigate one hundred acres. The shaft is about thirty feet deep and is six feet square. The bottom has a floor of concrete and the sides are lined with concrete for five feet and the remainder with boards. The motor and pump are direct-connected and are placed down in the shaft. A small house is built over the shaft containing the starting switches and circuit-breaker. The discharge and suction pipes are six inches in diameter. The discharge pipe is brought up the side of the shaft and the water is discharged at the level of the ground into a wooden flume. The flume was about one hundred feet long and empties into a ditch. The weir was placed at the end of the flume and leveled up. The instruments were connected in as follows: Phase 1-Watt. No. 3950 and Am. No. 62840; Phase 2-Watt. No. 3026 and Am. No. 78025. The summary of details of Plant No. 1 and data compiled from test is as follows:

PLANT NO. 1.

MOTOR—
Westinghouse Type "C" Induction Motor.
H.P. 7.5.
Volts, 200.
Constant Speed. 2-Phase.
Speed, 1120 r.p.m.
Amperes per terminal, 19.5.
No. 121838. 60 Cycles.

PUMP—
3.5 inch Single Horizontal Cent. Pump.
Number of acres irrigated—50 A.
Cost per H.P. per year, $50.
Cost of installation—

Well complete with curbing	$180
Motor and transformers	800
Total cost	$980

TABLE I.
TEST ON PLANT NO. 1.
DATA.

Time of Read.	Output Weir h″	h′	Input to Motor Phase 1 W_1	I_1	E_1	Phase 2 W_2	I_2	E_2
9:30	0.195	0.478	1.50	15.25	223.2	1.620	16.10	223.8
9:45	0.195	0.478	1.47	15.00	223.3	1.650	16.30	223.8
10:00	0.195	0.478	1.45	15.00	223.1	1.625	16.25	223.8
10:15	0.195	0.478	1.45	14.80	222.5	1.620	16.40	223.0
10:30	0.195	0.478	1.50	15.20	222.5	1.600	16.50	223.0

h″ is the zero reading on the weir in feet.
h′ is the final reading on the weir in feet.
h_0 = 40.5 feet = The Static Head.

TABLE II.

CORRECTED DATA AND CALCULATIONS.

Weir Effective head	Input to Motor. Phase 1 Multiplier = 2			Phase 2 Multiplier = 2		
h	W_1	I_1	E_1	W_2	I_2	E_2
ft.	kw.	Amp.	Volts	kw.	Amp.	Volts
0.283	1.499	14.79	223.3	1.622	15.65	223.95
0.283	1.470	14.52	223.4	1.652	15.83	223.95
0.283	1.448	14.52	223.2	1.627	15.81	223.95
0.283	1.448	14.31	222.6	1.622	15.96	223.15
0.283	1.499	14.73	222.6	1.602	16.07	223.15
Average—						
0.283	2.946	14.57	223.02	3.250	15.86	223.63

$W_0 = W_1 + W_2 = 2.946 + 3.250 = 6.196$ K.W. = Input = 8.3 h.p.

$E_1 I_1 = 223.02 \times 14.57 = 3249$ Volt-amperes.

$E_2 I_2 = 223.63 \times 15.86 = 3547$ Volt-amperes.

$E_1 I_1 + E_2 I_2 = 3249 + 3547 = 6796$ Volt-ampere input.

$$\text{Power Factor} = \frac{W_0}{EI} = \frac{6196}{.6796} = 91.2\%.$$

CALCULATIONS FOR EFFICIENCY.

Discharge—

c — from Tables = .613 feet.
b — length of weir = 1.5 feet
h — effective head over weir = 0.283 feet.
Q = 0.741 Sec. Feet.

$$\text{Output} = \frac{Q\,p\,h_0}{550} \text{ H.P.}$$

h_0 = Static Head = 40.5 Feet.
Q = Sec. Ft. = 0.741.

$$\text{Output} = \frac{.741 \times 62.3 \times 40.5}{550}$$

$= 3.40$ H.P.

$$\text{Eff} = \frac{\text{Output}}{\text{Input}} = \frac{3.40}{8.30} = 11.0\%$$

Instruments used	Phase 1		Phase 2
Ammeters	62840		78025
Wattmeters	3950		3026
Voltmeter		6270	

Plant No. 2 is owned by H. Davis and is situated about one quarter of a mile southeast of Exeter. The pump is used to irrigate twenty-five acres. The motor is a 5 h.p. induction motor and is direct-connected to a 2½ inch horizontal centrifugal pump. The shaft is five feet square and is lined with boards. The motor and pump are placed diagonally across the bottom of the shaft. The discharge pipe is five inches in diameter and discharges into a wooden flume twenty feet long. The weir-box was placed at the end of the flume. The small house at the surface contained the starting switch and fuses. Watt. No. 3950 and Am. No. 78025 were connected in Phase 1 and Watt No. 3026 and Am. No. 62840 were connected in Phase 2. The summary of details of Plant No. 2 and data compiled from test is as follows:

PLANT NO. 2.

MOTOR—

General Electric Co. Induction Motor
Type 10-4-5a-1800. Form K
H.P., 5.0.
Volts, 220.
Constant Speed. 2 Phase.
Speed, 1800 R.P.M.
Amperes per terminal, 11.0.
No. 133903. 60 Cycles.

PUMP—

Price, New Style.
2.5 inch Horizontal Centrifufal Pump.
Number of acres irrigated—25 A.
Cost per H.P. per year, $50.
Cost of Installation, $900.00.

TABLE III.

TEST ON PLANT NO. 2.

DATA

Time of Read.	Output Weir h''	h'	Input to Motor Phase 1 W_1	I_1	E_1	Phase 2 W_2	I_2	E_2
11.30	0.204	0.399	0.90	9.50	249.0	0.88	9.50	248.7
11:50	0.204	0.399	0.92	9.50	249.0	0.88	9.50	249.0
12:10	0.204	0.397	0.95	9.60	249.0	0.86	9.60	249.0
12:30	0.204	0.397	0.94	9.60	249.0	0.86	9.60	249.5

h'' is the zero reading on the weir in feet.
h' is the final reading on the weir in feet.
h_0 is the static head = 38.5 feet.

TABLE IV.

CORRECTED DATA AND CALCULATIONS

Weir Effective head	Input to Motor. Phase 1 Multiplier = 2			Phase 2 Multiplier = 2		
h	W_1	I_1	E_1	W_2	I_2	E_2
ft.	kw.	Amp.	Volts	kw.	Amp.	Volts
0.195	0.939	8.60	249.0	0.880	8.77	248.70
0.195	0.919	8.60	249.0	0.860	8.77	249.00
0.193	0.949	8.70	249.0	0.860	8.87	249.00
0.193	0.939	8.70	249.0	0.860	8.87	249.5
Average—						
0.194	1.873	8.65	249.0	0.865	8.82	249.05

W_0 = Total Input.

$= W_1 + W_2 = 1.873 + 1.73 = 3.603$ KW. = 4.83 H.P.

$E_1 I_1 = 249.0 \times 8.65 = 2154$ Volt-amperes.

$E_2 I_2 = 249.05 \times 8.82 = 2197$ Volt-amperes.

$E_1 I_1 + E_2 I_2 = EI = 4351$ Volt-ampere input.

$$\text{Power Factor} = \frac{W_0}{EI} = \frac{3603}{4351} = 82.9\%.$$

CALCULATIONS FOR EFFICIENCY.

Discarge—

c — from Tables = .622.
b — length of weir = 1.5 feet.
h — effective head over weir = 0.194 feet.
Q = 0.427 Sec. Feet.

$$\text{Output} = \frac{Q\,p\,h_0}{550} \text{ H.P.}$$

h_0 = Static Head = 388.5 feet.
Q = Sec. Ft. = 0.427

$$\text{Output} = \frac{0.427 \times 62.3 \times 38.5}{550}$$

$= 1.86$ H.P.

$$\text{Eff} = \frac{\text{Output}}{\text{Input}} = \frac{1.86}{1.83} = 38.5\%$$

Instruments used	Phase 1		Phase 2
Ammeters	78025		65840
Wattmeters	3950		3026
Voltmeter		6270	

Plant No. 3 that was tested was owned by E. J. Norcross and was used to irrigate forty acres. It is located one-half mile southeast of Exeter. The shaft was thirty-two feet deep and was six feet in diameter, the bottom of the shaft was cemented and the sides were curbed with brick. The motor was 7½ h.p. and was direct-connected to a 3½ inch centrifugal pump. The water was discharged through a six-inch pipe into a small concrete receiver. There were two small concrete flumes by which the water was carried from the receiver to the groves. The weir-box was set up just outside the receiver and the water flowed directly from the receiver into the weir-box. The same system of connections were used as before. Watt. No. 3950 and Am. No. 78025 in Phase 1 and Watt. No. 3026 and Am. No. 62840 in Phase 2. As in the other plants the small housing at the surface contained the starting switches and the circuit breaker. The summary of details of Plant No. 3 and data compiled from test is as follows:

PLANT NO. 3.

MOTOR—

Westinghouse Type C Induction Motor.
H.P., 7.5.
Volts, 200.
Constant Speed. 2-Phase.
Speed, 1120 R.P.M.
Amperes per Terminal, 19.5.
No. 262592. 60 Cycles.

PUMP—.

Single Horizontal Centrifugal Pump.
Size, 3.5 inch.
Number of acres irrigated, 40 A.
Cost per H.P. per year, $50.

Cost of Installation—

Well complete with curbing....	$ 200
Motor and transformers.......	.. 800
Total	...$1000

TABLE V.
TEST ON PLANT NO. 3.
DATA.

Time of Read.	Output Weir h″	h′	Input to Motor. Phase 1 W_1	I_1	E_1	Phase 2 W_2	I_2	E_2
4.00	0.188	0.380	1.44	16.5	223.0	0.86	11.0	215.0
4.20	0.188	0.385	1.42	16.8	224.0	0.83	10.8	215.0
4.40	0.188	0.385	1.45	16.5	224.0	0.87	10.7	215.0
5.00	0.188	0.385	1.40	16.7	224.0	0.84	10.5	215.0

h″ is the zero reading on the weir in feet.
h′ is the final reading on the weir in feet.
h_0 is the static head = 40.0 feet.

TABLE VI.
CORRECTED DATA AND CALCULATIONS.

Weir Effective head h ft	Input to Motor. Phase 1 Multiplier = 2 W_1 kw.	I_1 Amp.	E_1 Volts	Phase 2 Multiplier = 2 W_2 kw.	I_2 Amp.	E_2 Volts
0.192	1.438	16.07	233.6	0.860	10.37	215.5
0.197	1.419	16.38	224.6	0.830	10.16	215.5
0.197	1.449	16.07	224.6	0.870	10.06	215.5
0.197	1.399	16.28	224.6	0.840	9.85	215.5
Average— 0.196	1.426	16.20	224.35	0.850	10.11	215.5

$W_0 = W_1 + W_2 =$ Total Input.
$= 2.852 + 1.700 = 4.552$ KW. $= 6.10$ H.P.
$E_1 I_1 = 224.35 \times 16.20 = 3634$ Volt-amperes.
$E_2 I_2 = 215.50 \times 10.11 = 2178$ Volt-amperes.
$E_1 I_1 + E_2 I_2 = EI = 5812$ Volt-ampere input.

$$\text{Power Factor} = \frac{W_0}{EI} = \frac{4552}{5812} = 78.4\%$$

CALCULATIONS FOR EFFICIENCY.

Discharge—
c — from Tables = .622.
b — length of weir = 1.5 feet.
h — effective head over weir = 0.196 feet.
Q = 0.433 Sec. Ft.

$$\text{Output} = \frac{Q\, p\, h_0}{550} \text{ H.P.}$$

h_0 — Static Head = 40 feet.
Q — Sec. Ft. = 0.433.

$$\text{Output} = \frac{0.433 \times 62.3 \times 40.0}{550}$$

1.97 H.P.

$$\text{Eff} = \frac{\text{Output}}{\text{Input}} = \frac{1.97}{6.10} = 32.4\%$$

Instruments used	Phase 1	Phase 2
Ammeters	78025	62840
Wattweters	3950	3026
Voltmeter	6270	

Costs.

In calculating the costs it was assumed that two acre-feet of water were required for each acre of land per year, deducting for the rainfall. Following are the results calculated on this basis.

	Plant No. 1	Plant No. 2	Plant No. 3
Efficiency	41.0%	38.5%	32.4%
Cost per acre-ft. per ft. lift at $50 per h.p. per year	$.102	$.125	$.096
Cost per acre-ft. per ft. lift at $.01 per kw.-hr.	$.025	$.027	$.032

Conclusion.

The tests were made before the pumping season proper and the water level ordinarily is high at this time. But as it was an unusually dry season we have reason to believe that the water level was sufficiently near the average during the pumping season.

Taking the average of the three plants we have the following results:

(1) Average efficiency 37.5%
(2) Average cost per acre-foot per foot lift at $50 per h.p. per year .... $.107
(3) Average cost per acre-foot per foot lift at $.01 per kw.-hr. .... $.028

In conclusion we wish to acknowledge the kindness of the owners of these plants in allowing us to make the tests. Special thanks are due Prof. Noble and Mr. Gilcrest of the University of California for their valuable assistance.

ELECTRIC POWER FROM INDIA'S RAINFALL.

BY CONSUL EDWIN S. CUNNINGHAM, BOMBAY.

The Tata Hydroelectric Power Supply Company has been organized to furnish power for industrial purposes to this section of western India. This power will not be derived from permanent streams, but it is the company's intention to gather in reservoirs the very heavy rainfall, and use it for creating electric energy.

During the monsoon season, from the middle of June to the middle of September, there is a rainfall on the west coast of India that averages 175 inches at Lanouli, sometimes greatly exceeding this average. In the early part of the present century there was conceived the plan of storing this water and utilizing it for industrial purposes. After thorough investigation and reports of engineers, the money was practically secured in Europe in 1907, but final arrangements were not made, and as a result the entire capital of 20,000,000 rupees ($6,486,666) has been subscribed in India, making the enterprise purely an Indian undertaking. The present company was formally registered on November 7, 1910. It is the intention at first to supply 40,000 horsepower, which will probably be increased in the near future.

It is planned to erect three lakes or reservoirs. The Lanouli Reservoir, which will store water to be used during the three months of the monsoons, will be large enough to hold sufficient water during the longest breaks in the rain at that season. It will approximate 1000 acres, formed by a dam 3800 feet long and 26 feet high, and its cubic capacity will be 380,000,000 feet. The Walwhan Lake is the second reservoir and is to serve for the remainder of the year. It will be situated about a mile and a half from Lanouli, and will be formed between two spurs of hills by a dam 4500 feet long and about 68 feet high. The area of the lake will be approximately 2½ square miles, with a capacity of 2,600,000,000 cubic feet. The dam will be of solid masonry fitted with sluices.

Later on it is expected that a third reservoir will be constructed beyond Walwhan Lake, with which it will be connected by a tunnel nearly a mile long running through the dividing ridges of steep hills which will form a watershed some 1200 feet above the level of the valley. This reservoir will have an area of 3174 acres, or nearly 5 square miles, with a capacity of 7,000,000,000 cubic feet of water.

The water, traversing an aggregate distance of nearly 4 miles, will be led through masonry ducts from the lakes to the fore bay, situated 2040 feet above sea level. Here it will enter pipes 6 feet in diameter, which will run down steep slopes and precipices to Khopoli. The head will be a little over 1730 feet, the static pressure being 680 pounds per square inch. The generating station will be at Khopoli, 300 feet above the sea and 90 miles from Bombay, where it is planned to use the energy for manufacturing purposes.

The water supply, as has been stated, is dependent entirely upon the rainfall. This has been made a question of study, and engineers who have surveyed the grounds say that there is no danger of a shortage of water, but that the power is practically as certain as anything could be.

CODE OF ENGINEERING ETHICS.

BY AMERICAN INSTITUTE CONSULTING ENGINEERS

Code of Ethics.—It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Institute of Consulting Engineers:

(1) To act for his clients in professional matters otherwise than in a strictly fiduciary manner or to accept any other remuneration than his direct charges for services rendered his clients, except as provided in Clause 4.

(2) To accept any trade commissions, discounts, allowances or any indirect profit or consideration in connection with any work which he is engaged to design or to superintend, or in connection with any professional business which may be intrusted to him.

(3) To neglect informing his clients of any business connections, interests or circumstances which may be deemed as influencing his judgment or the quality of his service to his clients.

(4) To receive, directly or indirectly, any royalty, gratuity or commission on any patented or protected article or process used in work upon which he is retained by his clients, unless and until receipt of such royalty, gratuity or commission has been authorized in writing by his clients.

(5) To offer commissions or otherwise improperly solicit professional work either directly or by an agent.

(6) To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects or business of a fellow engineer.

(7) To accept employment by a client while the claim for compensation or damages, or both, of a fellow engineer previously employed by the same client and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration or issue has been joined at law, or unless the engineer previously employed has neglected to press his claim legally.

(8) To attempt to supplant a fellow engineer after definite steps have been taken toward his employment.

(9) To compete with a fellow engineer for employment on the basis of professional charges by reducing his usual charges and attempting to underbid after being informed of the charges named by his competitor.

(10) To accept any engagement to review the work of a fellow engineer for the same client, except with the knowledge or consent of such engineer or unless the connection of such engineer with the work has been terminated.

Schedule of Fees.—As a general guide in determining fees for professional services, the American Institute of Consulting Engineers recognizes the propriety of charging: **A,** a per diem rate; **B,** a fixed sum; or **C,** a percentage on the cost of work, as follows:

A—Per Diem Rate.

(1) Charges for consultations, reports and opinions should vary according to the character, magnitude and importance of the work or subject involved, and according to the experience and reputation of the individual engineer, from $100 per day to a higher figure, and in addition, where expert testimony is required or where otherwise conditions warrant so doing, a retainer varying from $250 to $1000 and upward. An additional charge should be made for all actual expenses such as traveling and general office expenses and field assistants and materials, with a suitable allowance for indeterminate items. In such cases six hours of actual work should be considered one day, except that while absent from the home city each day of twenty-four hours or part thereof should be considerad one day, irrespective of the actual hours of time devoted to the case.

B—Fixed Sum.

(2) A fixed total sum for above-mentioned services may be agreed on in lieu of per diem charges. A fixed sum may also be charged for a portion or all of the items of preliminary surveys, studies, examinations, reports, detail plans, specifications and supervision, including all of the expenses above recited in (**A**).

C—Percentages on the Cost of Work.

(3) For preliminary surveys, studies and report on original project, or for examination and report on project prepared by another engineer, including in both cases all expenses of every nature except those that may be specifically omitted by agreement—from 1½ per cent to 3 per cent on the work.

(4) For the preliminary stage (3) and in addition thereto detail plans and specifications for construction, including all expenses of every nature except those that may be specifically omitted by agreement—from 2½ per cent to 5 per cent on the estimated cost of the work.

(5) For the preliminary and middle stages (3) and (4) and in addition thereto general supervision during construction, including all expenses of every nature except those that may be specifically omitted by agreement—5 per cent, but more for work costing comparatively small amounts, and from 4 per cent to 5 per cent where the amount involved is considerable.

(6) For full professional services (3), (4) and (5) and management, including the awarding of contracts, and including all expenses of every nature except those that may be specifically omitted by agreement, 10 per cent; but more for work costing comparatively small amounts, and 6 per cent to 10 per cent where the amount involved is considerable.

(7) When desired, the percentage basis may be adopted for one or more stages, supplemented by a daily or monthly charge or fixed sum for the remaining stage or stages.

D—General Provisions.

(8) The period of time should be designated during which the agreed percentages and daily or monthly charges or fixed sum shall apply and beyond which period an additional charge shall be made.

(9) The percentages are to be computed on the entire cost of the completed work or upon the estimated cost, pending execution or completion.

(10) Payments shall be made to the engineer from time to time in proportion to the amount of work done.

(11) When alterations or additions are made to contracts, drawings or specifications, or when services are required in connection with negotiations, legal proceedings, failure of contractors, franchises or right-of-way, a charge based upon the time and trouble involved shall be made in addition.

BOWLING ALLEY LIGHTING.

BY F. W. LOOMIS.

Bowling alley lighting seems to be a subject upon which very little thought or study has been given in the past, at least one would so surmise on looking over the illumination of the average alley.

Taking the general run of alleys, the outlets are found spaced too far apart, and usually the light sources are unshielded, giving the effect of a few bright spots of light down the lenghth of the alley, together with a full quota of glare in the bowler's eye. Possibly the lamps are partially covered, but the outlets being unequally spaced give an unbalanced effect of light and shadows on the alley, which accentuates the glare from its smooth surface.

the alleys—the spacing between units and mounting heights being maintained—but, of course, outlet No. 9 should be placed over the pins on each alley. Likewise two rows of units between may be used for three or four alleys. One row of light sources should never be used to illuminate more than two alleys. Either drop-cords or stems may be used, it being only essential that the units hang pendant.

Where the ceiling is low, as in some basement alleys, it is a good plan to conceal the units back of false beams. When this is done the type of reflector can be varied, using a steel or glass, focusing or concentrating type mounted on an angle receptacle, blocking the receptacle to point towards the pins, or down the length of alley, at approximately thirty degrees.

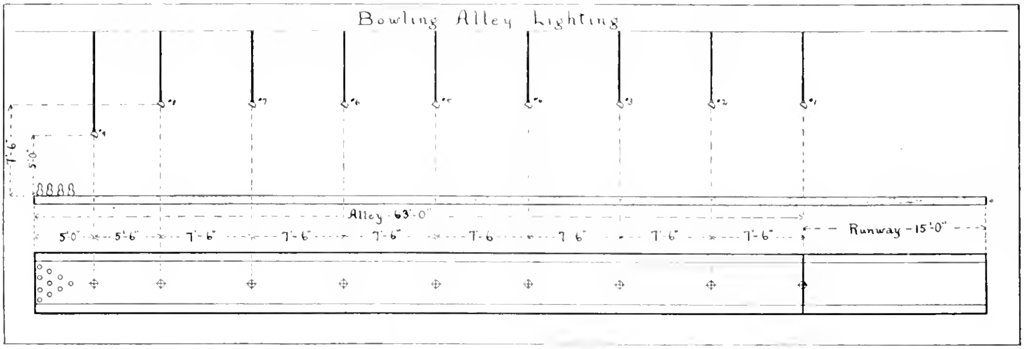


Fig. 1. Typical Illustration of Bowling Alley Lighting.

It is the object of this article to show what may be considered the best of systems for the illumination of bowling alleys, a system designed along scientific lines. The results are as follows:

1. The eye of the bowler is protected from glare.
2. The illumination down the alley is evenly balanced.
3. The pins stand out sharply at end of alley owing to a good strong intensity of light projected upon them at this point.

The length of the standard bowling alley is sixty-three feet, measured from the foul line to the end of alley. This does not include the runway. Over this length should be spaced nine outlets. (See illustration, Fig. 1). The first (No. 1) being placed over the foul line. Outlets Nos. 1 to 8 should be spaced seven feet six inches apart, and all eight should be hung seven feet six inches above the alley. The spacing between Nos. 8 and 9 should be five feet six inches and No. 9 mounted five feet above the alley, which will give a stronger light on the pins than over the balance of the alley.

The lamps are 40-watt clear Mazda or Tungsten, standard base, used with a thirty degree angle steel reflector (Holophane D'Olier No. 51). This combination of lamp and reflector will give an average intensity of illumination of 1.5 foot candles the length of the alley, and of 4.0 foot candles over the pins.

The light sources should hang pendant.

When two alleys are placed side by side, a single row of eight lights may be placed mid-way between

A concealed system of this kind has a much better appearance than one where drop cords or fixtures are used.

Note:—Should long base 40-watt lamps be used, No. 54 Holophane D'Olier Steel Reflector should be used in place of No. 51

MODEL CONTRACT FORMS FOR ORNAMENTAL STREET LIGHTING AGREEMENTS.

The paper of L. S. Twomey delivered before the San Francisco branch of the A. I. E. E. on June 23d, relative to methods of calculating illumination has developed much thoughtful discussion among the readers of the Journal. One point which came up for discussion was the question of contracts given by a corporation to light certain streets in return for franchise privileges.

A valuable feature of the report of the Committee on Ornamental Street Lighting, which was delivered before the recent N. E. L. A. Convention in New York, was the set of model contract forms submitted, as embodying the best elements of the various agreements in force between central station, municipality and property owner in the different cities where the decorative lamp post has been successfully introduced. Several examples are of record of the danger which lies in insecure agreements that permit the neglect or abandonment of portions of the installation, where one of the original merchants moves away and the new tenant refuses to assume his obligation. Like-

wise, the adequate profit to the central station must be safeguarded and the uniform effectiveness of the installation maintained. Therefore, much depends on the form of contract on which the agreement is based.

The committee has offered this set of forms as a guide to companies who are fostering the ornamental street lighting idea and formulating their plans for its establishment.

I.

Agreement Between Company and Merchants' Association Covering the Installation and Maintenance of Ornamental Post Lighting System.

This agreement entered into this, the .... day of ...., 19...., by and between the................. Company, party of the first part, and the Merchants' Association of the City of ...., party of the second part, to wit:

First: Party of the first part hereby agrees to furnish all labor and material necessary for installing an Ornamental Street Lighting System on .... Street, between.......... Street and .... Street, a distance of ....feet for party of the second part. Said Ornamental Lighting System, consisting of ornamental posts similar to drawings herewith attached, and placed as shown in map herewith attached. Wires for lighting said posts will be laid underground in conduit, in approved manner, and switches for turning system on and off will be placed.................. System will be complete from the mains of party of the first part to and including the last pole and will consist of conduits, wires, switches, posts, globes, lamps and al necessary appliances. Posts when set will be painted with one coat of .... color graphite paint.

Second: Party of the first part will, during the term of ....year ...... from the time lights are turned on the system, furnish the necessary current for lighting said system from .... each night, will turn system on and off nightly, will renew broken globes and lamps, will clean globes on the first and fifteenth of each month, and will paint each post with .... color paint once each year.

Third: For the work specified in Section One, party of the second part agrees to pay party of the first part the sum of .... Dollars ($.........) within one week from the time lights are turned on the system.

Fourth: For the service mentioned in Section Two, party of the second part agrees to pay party of the first part, on or before the tenth of each month following service, during the term of this agreement, the sum of .... Dollars ($...............).

Sixth: In the case of outages on the system, party of the first part agrees to rebate party of the second part, monthly, for outages of the previous month at the rate of .. .. cents per outage, per post per night.

Signed and sealed in duplicate, this the .... day of .... 19.....

....
....
....
....
....

II.

Agreement Between Property Owners and Tenants Covering Installation of Ornamental Post System.

We, the undersigned property owners and tenants on .... Street, between .... Street and .... Street, agree to pay to .... the amounts herewith placed opposite our signatures, said amounts being the amount of our frontage figured at the rate of .... per foot.

This payment is made to cover the cost of installation of a system of ornamental lighting on said street, specifications of said system being herewith attached and forming a part of this agreement.

It is understood that this agreement is not binding on the company unless all property owners and tenants on said street agree to pay for their frontage at the rate of .. .... per front foot, and that it is not binding on the owners and tenants unless the City of .... agrees to pay for the lighting and maintenance of said ornamental system, and the Company installs said system.

All payments are due within one week from time lights are turned on, and payable at the office of .... Company.

Name.	Owner or Tenant.	Frontage	Amount.
....	....	....	....
....	....	....	....
....	....	....	....

III.

Contract Between Company and City Covering Maintaining System of Ornamental Post Lighting installed by Property Owners and Tenants State of ....:

.... County:

This contract made and entered into this, the .... day of ...., 19...., by and between the .... Company, a corporation under the laws of ...., with its principal office in the city of..............., said State of ...., its successors and assigns, party of the first part, and the City of ...., a Municipal corporation of said State and County, party of the second part:

Witnesseth Whereas, there has been installed in the City of ...., a system of ornamental street lighting extending along .... Street, between .... Street and .... Street, consisting of .... ( ) .... ornamental columns with ....( ) watt Mazda lamps on each column;

And, Whereas, there is about to be installed a similar system of ornamental street lighting extending along .... Street from .... Street to .... Street, consisting of .... ( ) columns with............. ( ) watt Mazda lamps on each column;

And, Whereas, the said columns and equipment of the same were and are to be erected under various contracts with property owners and others, whereby the said columns equipped were to be and become the property of the City of .... and to be taken over into its contract as part of its public lighting system.

And, Whereas, the City of .... desires to provide for the maintenance and operation of the said system of ornamental street lighting by the party of the first part.

Now, Therefore, in consideration of the premises and the mutual covenants and agreements herein contained, it is contracted by and between the parties hereto as follows, to wit:

The party of the first part shall, during the continuance of this contract, maintain and operate the said system of ornamental street lighting heretofore installed and hereafter to be installed as herein above set forth, shall renew the Mazda lamps from time to time as necessary, renew the broken globes and keep the posts painted and keep the globes and poles cleaned, and shall furnish the current for lighting and operating the said lamps and turn on the lamps and turn them off from time to time, the said lights to burn from .... until ....on each night in the year. All the lamp globes shall be washed by the party of the first part on or about the first and fifteenth of each month during the continuance of this contract, it being the purpose that the said globes shall be washed twice each month, and they shall be subject to the inspection of the City Electrician.

The party of the first part agrees that all wires and cables supplying current to these lights shall be kept by it free from grounds and shall be maintained by it in first class condition.

The term of the contract shall commence from .... 19...., as to the lights already installed, and as to the lights not heretofore installed, it shall begin as to each post from the date when the lamps on the said post are first lighted, and shall continue until ... . 19...., and from year to year thereafter, subject, however, to the right of either party hereto to terminate this contract at any time after... . . 19...., by giving the other party written notice at least........ months prior to the time fixed in such notice for the termination of this contract.

The City of .... shall pay the .... Company for maintaining and lighting the said lamps as hereinbefore provided at the rate of .... ($.........) Dollars per year for each post or column, said sum to be paid by the City of .... in monthly installments on or before the .... day of each month, during the term of this contract, for the lamps in use during the preceding month.

That for such time as any of the lights are out, there is to be deducted from the price to be paid for such light a proportionate part of the contract price for the time such light or lights are out.

In Testimony Whereof, the .... Company has caused this contract to be signed in its name and behalf and its corporate seal to be affixed hereto by its President and Secretary, and the City of .... has caused the same to be signed on its behalf and its corporate seal to be hereto affixed by its Mayor, hereunto duly authorized.

Executed in duplicate on the day and year above written as the date thereof.

by .... Company.

.... President

.... Secretary

City of. ....

by............ .... Mayor

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Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
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CONTENTS

Transportation Facilities Panama-Pacific Exposition

The entire West has fairly vibrated during the past week with enthusiasm over the selection of the official site for the Panama-Pacific Exposition to be held at San Francisco in 1915. Petty jealousies and friction of all sorts have been entirely forgotten in the hearty, public-spirited endorsement received from all quarters.

The big exposition is held primarily to commemorate the greatest engineering feat of history. The site as selected emphasizes the two points that above all others should be most strongly dwelt upon; namely, the Panama Canal as a maritime triumph and the Canal as an engineering feat. The site includes a boulevard over four miles in length along the famous Golden Gate entrance where the commerce and navies of the world can boast their supremacy in full review before the exposition grounds. Secondly, the site selected includes within its confines the very heart of the once burnt district of the great city. This very district will, in itself, in 1915 present to the world the greatest exhibit of all, namely, the product and faith of a brave people, ground to the earth but resurrected in two hundred million dollar splendor to greet the nations of the earth.

Even this early there begins to loom up for consideration the problem which will bear the most careful consideration. The question of transportation, systematic in make-up and absolutely void of confusion for those who will be strangers at the fair, is of utmost importance. The choice of the site for the fair has done much to meet these conditions. The grounds will be accessible from many points and the approach by boat at Harbor View will mean much to alleviate conditions incident to the heavy flux of people from Oakland, Berkeley, Alameda and Marin County.

It is more the question of proper terminal equipment at the grounds itself which will need thoughtful planning. No more pitiful sight can be imagined than a mass of helpless people crowding and jostling together, struggling and fighting to get on cars and absolutely ignorant of which particular car to take.

The human race, representing the highest type of the vertebrate animal, never appears more devoid of sense, judgment and reason than when in a crowd that is trying to get somewhere and nobody knows particularly where. On such occasions the more we are handled like our cousins, the cow, the steer, and the sheep, the better. Experiences of the past have demonstrated that the more nearly the corrals can be constructed to resemble the cattle-shipping approaches of the great packing houses, the better. To prevent the wild mob from running down the tracks, thus entering within the dangerous enclosures, even the cattle pit-falls and water tanks have been found most expedient in the past. After the completion of the work according to this design the corrals are made graceful and attractive in finish, kept clean and sanitary at all times and embellished with minute explanatory signs. With this worked out to the highest degree, those having charge of the transportation facilities will present to the world during 1915 another triumph of engineering sagacity.

Patent Reports

The annual report of the Commissioner of Patents for the year 1910 has recently appeared in press. Elsewhere in these columns will be found a summarized statement.

Two points are of much interest in this compilation. The first is that, with the exception of California which appears third in the list, by all odds more patent fiends are found in the New England States, per capita, than anywhere else in the Union, and on the other hand the fewest in the Southern States and foreign possessions. Careful investigation explains this condition, not so much due to geographical conditions as to location of manufacturing centers where thousands of intricate mechanisms are manufactured and used. This goes to prove the old adage that "necessity is the mother of invention." In the South where farming is largely involved comparatively few inventions are necessary. Moreover these few, such for instance as the invention of the cotton gin, make necessary when they take place a reorganization of the farming industry.

As to why California should appear so near the top of the list is hard to explain, unless it is that the delightful and healthful scenery and surroundings on the Pacific Coast are conducive to the development of the particular philosophical turn of mind which leads to invention.

Another item of interest in the report is that although the amount of money received during the past year was the greatest in the history of the patent department, yet a surplus of only $19,824.75 appears to its credit, the same being the smallest surplus, with but one exception, for over thirty-five years. In looking into the details of the commissioner's report it is found that various salaries in the department have been increased, as no increase had taken place for over half a century. This increase in salaries has resulted in the department's being able to retain their expert men and recall others who had left the service for more lucrative places during the past years. This item of salaries alone makes a difference of fifty thousand dollars in expenditure. We cannot help but feel that the increase in salaries to the deserving men in the department has been wise and will bear fruitful results in future service for the government.

College Engineering Thesis

The advance in engineering methods has been so great that it has been necessary to modify continually the course of studies preparatory to the granting of an engineering degree in the great technical schools. In order to adapt the course of study to the best needs of the future engineer it is necessary to note the progress of students after their graduation from college. To the casual observer one of the most striking features is found in the fact that after graduation so many of those preparing for the electrical engineering profession find their life work in mining or civil engineering, and those taking courses in civil and mining engineering make a marked success in, let us say, electrical or chemical engineering. The interesting feature of it is that the young student has been trained in a special technicalized subject, yet by acquired training and concentrated application he is enabled after graduation to master single-handed the matter relating to a kindred but hitherto untouched subject, so far as his previous personal knowledge is concerned.

These examples which are constantly being brought to our attention furnish much food for serious reflection to those interested in seeing the young engineer acquire the proper foundation work at college. After long observation and serious thought two features of the necessary college curriculum to be undertaken by the engineer in embryo stand out most prominently. One is, that above all things the fundamentals of chemistry, English, physics and mathematics should be so hammered into those planning a future engineering career, that if at any time through life they should be awakened from a sound sleep they could with ease repeat and apply these fundamentals. The use of logarithms, the elementary applications of trigonometry, and the fundamentals of the mechanics of physics, such as Newton's Laws of Motion, should be mere bywords. The illustration found upon the blackboard some years ago at the University of Montana is not so foreign to the case after all. The professor had constantly warned his students that above all things in the course of the mechanics of physics they should get Newton's Laws of Motion down pat. The next day appeared upon the blackboard an illustration of an Irishman with mouth wide open, one cannon ball just entering and several following at high velocity, with the title below "Get 'em down Pat." The only modification we suggest is that the Irish student should not be alone in masticating these fundamentals.

The other point in the engineering course is the thorough mastery of some one particular piece of experimental work performed with the utmost detail and accuracy. The word "thesis" is usually applied to this work but is not strictly accurate, for there is hidden in the word something which means that the work undertaken should of necessity be something not hitherto known or understood. The main point, however, so far as its value to the young engineer is concerned is that his experimental work should involve original thinking for him and should be a model of painstaking accuracy in every detail.

Examples of an excellent type of thesis have appeared in the two previous issues of the Journal and another example appears in this issue. These theses were undertaken by certain students in the mechanical and electrical engineering departments of the University of California. In the issue of July 22d appeared a new method of measuring velocities in small pipes. Papers for the patenting of this process are already filed. In the issue of July 29th some new experimental data on wind velocities of small wires seem to indicate a new law hitherto unproven, while in this issue appears a series of practical tests on cost of irrigation by means of pumps electrically driven. Such work as this means the consumption of much mental tissue on the part of the student in planning his work and at the same time prepares him to fight life's battles with every weapon at his command.

PERSONALS.

Nathaniel Ellery, State Engineer of California, was a San Francisco visitor during the past week.

John Coffee Hayes, general manager of the Mt. Whitney Power Company, of Visalia, is again at San Francisco.

R. Leo Van der Naillen, superintendent of the Oro Water, Light & Power Company, with headquarters at Oroville, was at San Francisco recently.

S. K. Colby, vice-president of Pierson, Roeding & Co., has been spending his vacation at the Bohemian Grove, on the Rusisan River, in Sonoma County.

E. G. Alexander, purchasing agent of the California Electrical Construction Company, has returned to the San Francisco house after spending a vacation at Visalia.

Colonel Frank H. Ray of New York, who is extending the hydroelectric system of the Rogue River Light and Power Company in Oregon, recently spent several days at San Francisco on business.

Sidney Sprout returned to his San Francisco office during the past week, from a trip to Dorris, Cal., where Sprout & Sprout nave been retained as engineers for the installation of a municipal water system.

J. R. Wilson, sales manager of the Crocker-Wheeler Company, has returned to the factory at Ampere, N. J., after visiting the San Francisco agency while on a Pacific Coast tour in the interests of the company.

H. H. Noble, president of the Northern California Power Company, returned last Monday from an inspection tour, covering the Coleman station, the North Battle Creek dam, and the electric pig-iron plant at Heroult.

W. E. Barrett, chief gas engineer of J. G. White & Co. of New York, who recently arrived in California from Vancouver, B. C., spent the past week in consulting with H. A. Lardner, manager of the company's San Francisco office.

T. P. Strickland, chief assistant electrical engineer of the New South Wales Government Railways, with headquarters at Sydney, Australia, left for the East during the past week, after inspecting a number of the electric power plants in the vicinity of San Francisco.

H. V. Carter, president of the Pacific States Electric Company, and C. C. Hillis, general manager of the Electric Appliance Company, of San Francisco, will soon leave for the East as the delegates to the forthcoming annual convention of the National Electrical Jobbers' Association at Saratoga.

P. H. Coolidge, of the Pacific Telephone & Telegraph Company, has been transferred from the position of assistant general manager to that of general commercial superintendent and will remain at San Francisco. George B. Bush has been transferred from general commercial superintendent to assistant general manager, exchanging places with the former official.

Leo D. Haas, formerly connected with the lamp sales department of the California Electrical Construction Company at San Francisco, has taken a position in the commercial department of the Great Western Power Company, under J. H. Hornung. He is now working successfully at San Jose, which city the Great Western is preparing to invade with its electric transmission lines.

H. D. H. Connick, who was recently appointed director of works of the Panama-Pacific International Exposition, made an excellent record in the city engineer's office at San Francisco in charge of the new sewer system. Under his supervision, the first survey stake was placed during the past week in connection with the preliminary work of laying out the exposition grounds at Golden Gate Park.

F. W. Gay, of J. G. White & Co.'s Pacific Coast branch office, spent the past week in Southern California, looking over the electric power plant recently installed by his company, with a party of engineers. Among those who made an inspection of the Pacific Light and Power Company's large steam turbine generating plant at Redondo Beach were F. H. Varney and J. H. Wise, of the Pacific Gas and Electric Company.

ELECTRICAL CONTRACTORS' ASSOCIATION NEWS.

C. E. Schneider, of the Electric Supply Company of Sacramento, was in town during the week.

Q. R. Boynton, of the Central Electric Company of Los Angeles and San Francisco, has just returned from a month's stay in the South.

A. E. Brooke Ridley has just returned from a three weeks' fishing trip at Catalina Island, where he went to take in the Contractors' Convention.

In his talk before the electrical contractors at Catalina Island recently, H. V. Carter, president of the Pacific States Electric Company, used as a text the words of Judge E. H. Gary, chairman of the United States Steel Corporation, on the subject of "Co-operation."

"There should be established and continuously maintained," Judge Gary said, "a business friendship which compels one to feel the same concern for his neighbor that he has for himself. It is no less than the Golden Rule applied to business. Is it possible? Would it be certain to pay? It sometimes and too often happens that unfair action has been taken by those who have been given confidence by others, but this fact should dishearten no one.

"For example, take any two men in this room engaged in competitive business, but who are sufficiently acquainted to have the entire confidence of each other. Is there any doubt that in the daily conduct of their affairs neither would be disposed to do anything unneighborly or unreasonable toward the other; or that the acquaintance would bring to both better results than could be realized if they were unfriendly or engaged in bitter and destructive competition?"

The manner in which Mr. Carter handled the subject was excellent, and showed that in attaining his present high position that Mr. Carter was very familiar with all the branches of the business.

Secretary Hanbridge sends the following message to the California Electrical Contractors:

The Panama Exposition fair site has at last been decided, and now the qnestion is being asked by every Californian, What will the next few years bring?

Let us electrical people answer it by saying and resolving that we are going to bring every possible electrical man and his family to California in 1915, thus doing our mite towards helping this great work along.

The electrical bnsiness will receive a great many of the benefits derived from this great undertaking and let us show our electrical brethren that we are a unit.

There will be a great many conventions held in our cities during the fair and there never was a better reason why every branch of the business should be working together. There is a large family of us, and that is all the more reason why we should all gather under one roof. We have our engi-

neers, who must lay out the work, then our manufacturing companies, to whom we must look to make the apparatus; the jobbers, who must supply the material; the central station men, who must furnish the current; our telephone and telegraph men, who must furnish communication with all the world; our contractors, who must install the apparatus; our electrical journals, whose men must give the world the news, and last, but not least, our Sons of Jove, who furnish the good fellowship and play that is necessary for our hardy workers to recuperate so that they can conquer other worlds.

Oh you Panama-Pacific Exposition, what would you do without us!!

So, fellows, from the viewpoint of the writer this is our share of the work, so lest we forget—

All together all the time for everything electrical.

FOREIGN NOTES.

KUALA LUMPUR, MALAY STATES.—The total cost of the electric lighting of Kuala Lumpur, capital of the Federated Malay States, is now placed at $1,075,656, and maintenance cost $75,595 in 1910. The receipts amounted to $96,760, a profit of $21,165, or 19.7 per cent, which is an improvement on the year previous.

SAN GERONIMO, MEX.—A public service electric company is now installing apparatus to bring electric current from San Geronimo to this town. Heretofore no electric current has been available to the public, the only plant being the plant of the Tehauntepec National Railway, and this company used the power in connection with the terminal and dock facilities.

CALCUTTA, INDIA.—The military authorities of the Government of India have a plan of wireless telegraphy to knit together the various units of the army in India. Details are lacking, but four stations have been completed and the wireless apparatus is to be installed by the Marconi company. This is the first appearance of the company in India, the system at present in use for commercial and general purposes being the Lodge-Muirhead system. The scheme is exclusively for military use and it is understood that eventually every military station in India will have its wireless apparatus in charge of trained army officers.

BANGKOK, SIAM.—The Siam Electricity Co., (Ltd.), which owns the only large electric light plant in Bangkok, also the tram car lines, paid the usual dividend of 12 per cent and a bonus of $2.22 per share of $50, on 25,000 shares. It is said that the Siamese Government has decided to install its own electric power plant for the water-supply system, and also intends to provide electricity for lighting the palaces, parks, and districts adjacent to the pumping station. The electrical company now supplies the current for this lighting and if the Government should take over this work the company will sustain considerable loss fo revenue.

TRADE NOTES.

The Bunker Hill Mining Company at Amador City recently placed in operation a new 300-h.p. Westinghouse electric-hoist motor It operates a 2500-foot shaft with rope-drive connection.

The Hughes Electric Company of Glendive, Mont., has contracted with the Kellogg Switchboard and Supply Company of Chicago for a complete new central station and subscribers' stations. This system connects with the long-distance lines of the Eastern Telephone Company.

The Kellogg Switchboard and Supply Company has closed a contract with the Mount Hood Railway and Power Company of Portland, Ore., for a telephone system for their twenty-nine-mile electric railway line extending to Bull Run. Dispatchers and way station equipment, and Gill selectors are called for by the specifications. Gordon Kribs is the chief engineer. The first section of the road will soon be ready for operation.

The Western Electric Company recently sold to the United States Government a complete central battery exchange equipment to be installed at West Point, New York. This equipment consists of a multiple switchboard with a capacity of 3000 common battery lines, together with frames, racks, a complete power plant and 25,000 feet of paper insulated, lead covered underground cable. In addition to this, the contract calls for all the necessary telephone sets, protectors, outside distributing wire and the installing and connection of the underground cable.

The General Electric Company has been awarded a contract for a novel electrical installation for the United States collier Jupiter, now under construction at the Navy Yard, Mare Island, Cal. A 5450 kw. Curtis steam turbine generating set will supply three-phase current, to operate two slow-speed induction motors, each direct connected to one of the twin-screw propeller shafts. The nearest approach to this installation now in use in this country is in one of the Chicago fire boats with capacity of only 700 h.p. The new contract calls for one horizontal, 6-stage Curtis turbine, direct connected to an A. T. B. 2, 5450 kw., 1990 r.p.m., 2300 v. generator. Also, two I. 36, 2750 h.p., 110 r.p.m., Form M., 2300 v., variable-speed induction motors with water-cooled resistances. Also the necessary switchboards.

The Wagner Electric Mfg. Company of St. Louis has consummated arrangements with the Mine & Smelter Supply Company by which the latter concern will act as representative for the Wagner Company in the territory tributary to Denver, Salt Lake City, El Paso and Mexico City, Mexico. The Mine & Smelter Supply Company is the largest mining machinery house in the country. They, however, do not confine themselves to machinery and supplies required in the mining and smelting industry but also handle all classes of machinery in the districts covered by their stores and warehouses above enumerated. Mr. O. H. Davidson, heretofore the Wagner representative at Denver, becomes head of the electrical department of the Denver house of the Mine & Smelter Supply Company. In Salt Lake City, Mr. F. E. Marcey, for several years manager of the Salt Lake City office of the Allis-Chalmers Company, is manager of the Mine & Smelter Supply Company's office.

NEW CATALOGUES.

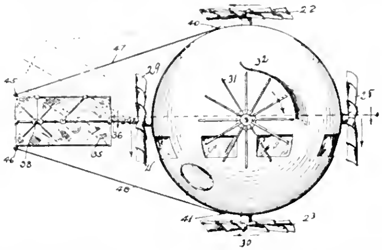
The Griscom-Spencer Company, 90 West Street, New York, have just issued Catalog No. 402 on the Thompson Evaporative Condenser, Catalog 1101 on the "Stratton" Steam Separator, a catalog on the G-S Hygienic Air Washer, and Bulletin 701 on the Morse Destructor Furnace.

The Fort Wayne Electric Works have just issued Bulletin No. 1130 on Northern Type K Direct Current Motors, Bulletin No. 1131 on Series Incandescent Street Lighting Systems, Bulletin No. 1132 on Multiphase Revolving Armature Alternators, Bulletin No. 1133 on Single-phase Watthour Meters Type K4. The four bulletins are profusely illustrated.

Folders 4204 and 4205 are the new publications that are being distributed by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa. No. 4204 is entitled "Telephone Battery Charging with Westinghouse-Cooper Hewitt Rectifier Outfits," and No. 4205 is entitled "The Right Light," and covers the use of the rectified current arc lamp with moving picture machines. These folders will be sent to anyone interested on application to the Westinghouse Department of Publicity.

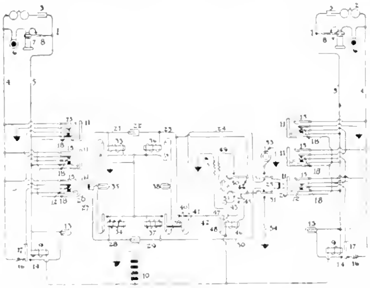
PATENTS

998,683. Centrifugal Aeroplane. Joseph W. Fawkes, Burbank, Cal. An air ship having a hollow spherical body, a rear shaft extending horizontally through the rear wall of said body, a propeller carried thereby for advancing said body, a steering vane having universal connection at the rear end of said shaft, cords connecting with the end of said steering vane and passing through the wall of said body on



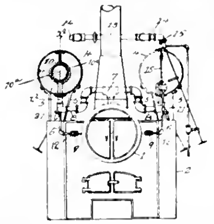
opposite sides thereof and substantially at the same level, means for operating said cords to move said vane to the right or left of said horizontal shaft, a pair of cords connected with said vane and passing through the walls of said body on the upper side thereof and on the under side thereof, means for adjusting said last pair of cords for elevating or depressing said last steering vane, and means for driving said propeller.

998,719. Telephone System. Charles A. Simpson, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill., a Corporation of Illinois. In a telephone system, the combination with a telephone line, of a source of current, a relay having its coil normally connected between



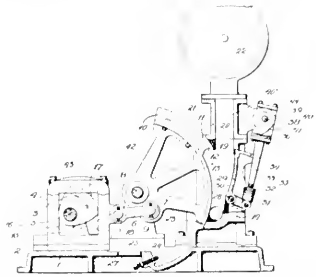
a pole of said source and a limb of said line, and the other limb of said line being normally connected with the other pole of said source through contacts of said relay, a line lamp, the actuation of said relay being adapted to complete a locking circuit through said line lamp and the coil of said relay, substantially as described.

998,816. Water Feed, Heater, and Purifier for Steam-Boilers. Samuel M. Walker, Los Angeles, Cal. A water feed, heater and purifier for steam boilers, comprising a firebox, a boiler shell supported by the firebox, two horizontally arranged drums supported on the firebox, one on each side of and above the boiler shell, pipe connections each having a valve and extending from the lower part of the outer end of the drums to the boiler shell, a centrally arranged steam outlet pipe, surmounting the top of the boiler shell, provided with transverse branches each having a valve and extending laterally, downwardly and across the fire box and longitudinally parallel with the boiler shell and beneath and upwardly into their respective drums, longitudinal tubular headers, each having a perforated lower half with which the branch pipes connect and an imperforate upper half and twin frames whereby the tubular headers are supported centrally



within their respective drums, water supply connection, provided with branches each having a valve and connected with the top of the drums and blow off pipes having valves and connected with their respective drums.

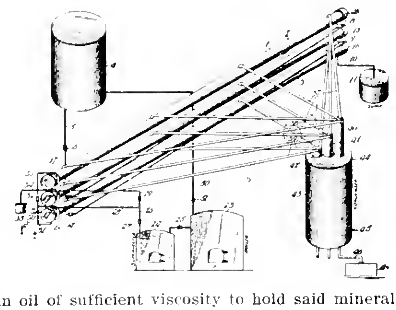
998,625. Fuel Press. David C. McCan, Los Angeles, Cal. In a fuel press, the combination with a casting having a semi-cylindrical groove and a feed chamber mounted thereon, of a sector provided with a shoe having a semi-circular groove,



and arranged to form with said semi-circular groove in said casting, a complete cylindrical mold, a gate to close the feed chamber and compress the material against said sector and means to operate said gate and sector.

998,837. Process of Refining Oil. Hubert G. Burrows, Orcutt, Cal. The process of refining oil containing finely divided mineral matter in suspension, which consists in distilling the oil with sufficient rapidity to cause the finely divided mineral matter to pass into the distilled product and condensing the distilled product into liquid form, and allowing the mineral matter to settle out from the oil.

The process of separating finely divided mineral matter



from an oil of sufficient viscosity to hold said mineral matter permanently in suspension.

INDUSTRIAL

POWER FACTOR METERS.

A poor power factor can often be improved by a better proportioning of the motors to their loads, the use of a super-excited synchronous motor, or similar means, with resulting increased capacity and efficiency of the system. It is therefore important, particularly in heavily loaded plants, to know what the actual power factor is at various conditions of load. To do this it is not necessary, as it once was, to take readings of voltage, current and power and to calculate from these the ratio of true to apparent watts. The introduction of direct-reading power factor meters has made calculation unnecessary and enables the determination of the power factor without trouble. Their use indicates whether induction motors on a system or on any circuit of a system are being properly operated, and enables the adjustment of the exciting current of synchronous apparatus to values giving the most economical power factor, also indicating a reversal of power if it occurs.

On polyphase systems supplying a mixed load, power factor indications are a necessity, as the calculation of power factor from other meters is very complicated and difficult and may give very misleading results. A polyphase power factor meter having current connection in each phase of the circuit will indicate the average power factor of all the phases.

The illustrations show four types of direct reading power factor meters manufactured by the Westinghouse Electric & Manufacturing Company. These meters indicate on a graduated scale the power factor in the circuit to which they are connected.

The power factor meter operates on the rotating field principle. A rotating field is produced by the current of the metered circuit passing through angularly placed coils. In this rotating field is situated a pivoted iron vane or armature, magnetized by a coil whose current is in phase with the voltage of one phase of the circuit. As the iron vane is attracted or repelled by the rotating field of the current coils, it will take up a position where the zero of the rotating field occurs at the same instant as the zero of its own field. Thus its position will always indicate the phase angle between the voltage and current of the circuit. The pointer attached to the armature therefore indicates this angle, and, by marking on the scale the cosine of the angle shown by the graduation, the power factor is read directly. In the three-phase meter the rotating field is produced by three current coils spaced 60 degrees apart; in the two-phase meter by two current coils spaced 90 degrees; in the single-phase meter the position of voltage and current coils is interchanged and the rotating field is produced by means of a split-phase winding.

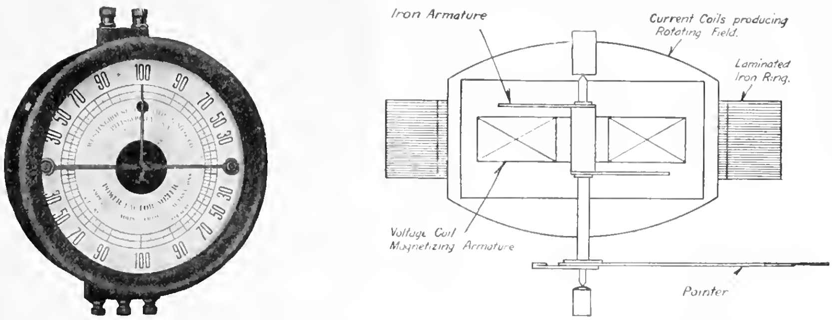


Fig. 1. Outer Damping Disk and Rotating Field of New Power Factor Meter.

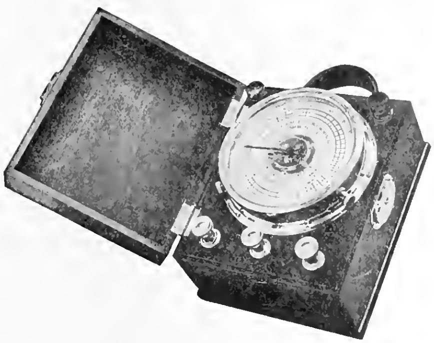


Fig. 2. New Type of Power Factor Meter

Fig. 1 illustrates the movement of a type SI seven-inch power factor meter. The winding shown within the iron ring is the stationary winding of the current coils. Inside this and not shown, are the stationary voltage winding and the pivoted armature. The laminated iron ring surrounding the winding is provided as a return circuit for the flux of the pivoted armature, so that the reluctance of the armature magnetic circuit is low and uniform in all positions. These parts are shown in the diagrammatic cross-section, Fig. 1.

An aluminum disk shown in Fig. 1 at the front of the meter is a damping disk, moving in the concentrated field of the two permanent magnets at the bottom of the mechanism. These magnets and disk have no effect whatever on the electrical operation of the meter. They serve to absolutely prevent oscillations of the pointer and thus make the readings "dead-beat." The pointer therefore does not swing back and forth but comes to rest at once at its correct position. More efficient damping is obtained with this electromagnetic device than is possible with air damping devices, unless a delicate and easily deranged adjustment is resorted to.

It will be noted that in this form of power factor meter

no connection is required between the fixed and the moving elements; there being no movable coils used, there are no delicate flexible connecting strips; nor is any control spring necessary, as the controlling force is electromagnetic. The moving element is therefore very light, and the friction and bearing jewel wear a minimum.

All the Westinghouse switchboard types and the polyphase portable types are arranged to read lagging or leading power factor on the upper half of the scale and for reversed power on the lower half. The switchboard types are adjusted for one standard frequency; the polyphase portables are adjustable to any frequency between 25 and 60 cycles. The single-phase portables indicate for 60 cycles on one-half the scale and for 25 cycles on the other half. The portable meters are very convenient for investigating the power factor of motor loads and assist very materially in improving the operation of the system.

A NEW MOISTURE-PROOF DRY BATTERY.

Where considerable moisture is prevalent it sometimes happens that the cardboard cartons of dry cells absorb so much moisture that when the cells are placed side by side or on a metallic base, they become short circuited. This causes them to run down and deteriorate quickly, thus necessitating frequent renewals and an attendant maintenance expense.

The Western Electric Company, realizing this, has recently placed on the market a new, moisture-proof dry battery. This cell has been designed especially for use in mine, railway and general telephone service where the batteries are subjected to moisture. The new cell has the same high efficiency, long life, high voltage and great recuperative power which characterizes the standard "Blue Bell" battery. It differs from the standard cell in that the cardboard carton has been treated with a special impregnating compound which effectually prevents moisture from reaching the cell proper. This will give sufficient protection so that the life of the batteries used in damp places will be as great as that of the batteries used in any other magneto service under ordinary conditions.

BOOK REVIEW.

Straight Line Engineering Diagrams. By Manifold & Poole, Pocket size, 4½x7½ inches; 96 pages, 44 line drawings; 5 half-tones illustrating emergencies in engineering; clear type; strong paper; durable bindings. Published by Technical Publishing Co. and for sale by Technical Book Shop, San Francisco. Price $3.00.

Briefly this book in convenient pocket form contains forty-four carefully compiled diagrams from which data relating to transmission lines, pipes, canals, concrete, steel, wires, and practically every problem coming up in the practice of the engineering profession is solved at a glance. In the rear are five illustrations, covering emergencies or what is to be done in case of electrical and other accidents.

Manifold & Poole, engineers, Los Angeles, California, put into ready graphical shape in this work not only formulae in common usage among engineers, but also the clever ideas gathered from a wide and varied practice.

Every engineer is experiencing daily the long felt want for some self-speaking volume of ready data. Let us cite by illustration: A friend drops in upon an electrical acquaintance. The friend is figuring up a prospect in the way of an irrigation enterprise and wants to know quickly the approximate size of a ditch to convey given amounts of water and approximately the yardage to be excavated. The electrical engineering acquaintance let us say is an expert in matters electrical. Ask him anything about voltage, size of conductors, transmission lines and the like and he gives you the data from the pigeon-hole in his brain at once. But now here is an irrigation problem before him. His mind runs back to years ago when last he used Kutter's Formula. It takes him an hour or two to figure out correctly the rough data his friend desires. Again the civil engineer has constantly propounded to him questions of engineering he cannot readily answer.

This little book, if carefully examined, will be found bubbling over with just the ready information desired and the ease and rapidity with which the diagrams can be read will always remain a mystery to the uninitiated. The book should be in the pocket of every engineer.

Testing of Electro-Magnetic Machinery and Other Apparatus. By B. V. Swenson and Budd Frankenfield, assisted by J. M. Bryant. Size 5½ x 8½ inches; 324 pages. Profusely illustrated line drawings. Published by The Macmillan Company, New York, and for sale by Technical Book Shop, San Francisco. Price, $3.00 net.

The methods employed in this book setting forth the laboratory tests for the electrical engineering student combine the practice and suggestion of half a dozen or more university laboratories as well as suggestions from the laboratories of such electrical manufactories as Allis-Chalmers Company. The book has been tried out in mimeograph form in the classroom for the past six years and represents a product of such correction and remodification that it is believed will meet more nearly the classroom needs than any book yet published of this nature. The arrangement is logical. Each series of tests begins with a list of standard references. The object is thus set forth to focus the student's attention and this is followed by the author's theory and method. The book comes upon the scene at a time most welcome to those interested in electrical engineering laboratory tests.

Walker's Manual of California Securities and Directory of Directors, 1911 Edition. Edited, compiled and published by H. D. Walker, San Francisco, Cal. Size, 6 x 9 inches; 472 pages. Replete with data relative to California securities. For sale by Technical Book Shop, San Francisco. Price, $5.00 net.

The new publication contains many valuable features over its predecessors. Not only is definite information given regarding the number of corporations and their securities which are listed on the Exchange and dealt in by the public, but a number are compiled which are not listed on the Exchange, but which are dealt in by the public. This represents much new and valuable information. The Directory or Directors has also been added to and made more complete. The book is invaluable to those holding securities in the great power companies and other public service corporations of California.

NEW CATALOGUES.

The D. & W. Fuse Company of Providence, R. I., have just published Catalog No. 15, containing a complete line of fuses, cut-outs, boxes, etc. The publication is well illustrated and attractive in appearance.

The Ohio Brass Company have just published Supplement No. 2 which contains many interesting and important improvements in various materials listed in their former catalogs on railway, mine, catenary and O.B. Hi-Tension specialties.

The General Electric Company has just issued a very attractive publication in Bulletin 4855, devoted to a detailed description of its double truck type of gas-electric car. The publication is elaborately illustrated, and contains considerable data relative to the subject. It includes plans and elevations of cars of various sizes. In Bulletin No. 4863, recently issued by the company, is described that company's Gem lamp. This lamp is intended to replace the carbon lamp as a free renewal lamp. The bulletin compares the carbon with the Gem lamp and shows the advantages derived by the use of the latter.

NEWS NOTES

FINANCIAL.

OROVILLE, CAL.—The Oro Water, Light & Power Company has been cited to appear before the Board of Equalization to show why its assessment on certain non-operative property should not be increased from $12,950 to $50,000.

LOS ANGELES, CAL.—The City Council has passed an ordinance providing for the issuance of $3,500,000 of Electric plant bonds of the city authorized at a special election held April 19, 1910. The bonds to be $1000 each, dated June 1, 1911, bearing 4½ per cent interest, payable semi-annually.

MORGAN HILL, CAL.—Sealed bids will be received by the clerk of the Board of Trustees at the town hall, up to August 10, 1911, for the purchase of the whole or any part of the $13,000 bond issue, for the acquisition and construction of a system of waterworks. The bonds are 26 in number of the denomination of $500 each, bearing interest at the rate of 3 per cent per annum.

SACRAMENTO, CAL.—That $1,500,000 will be spent by the Citizens' Light & Power Company of this city, a subsidiary of the Great Western Power Company, was announced last week by George W. Peltier, president of the company. This money will be expended in putting in an underground conduit system and wiring the city for electric lighting and for power. The company will file articles of incorporation, with $5,000,000 as capital stock, some time this week. It will commence operations at once.

SAN FRANCISCO, CAL.—Through a $2,000,000 bond deal closed in New York by the promoters of the Antioch & Oakland Railroad the extension of the road into Oakland and Stockton is now assured. The new road has a traffic agreement with the Key Route which will permit its cars to reach the pier of that system and to run to the heart of Oakland. The new company also holds a franchise along Shafter avenue in Oakland in the name of the Oakland and Bay Shore Railroad. Two blocks of land at Shafter avenue and Fortieth street will be the operating headquarters, where the line will connect with the Key Route. The Anglo Californian Trust Company will act as trustee in the bond deal.

SAN FRANCISCO, CAL.—The Spring Valley Water Company has applied to the Supervisors for a reduction of its assessment in San Francisco to the extent of $2,746,199. Assessor Dodge this year assessed the company as follows: Real estate, $3,056,000; improvements, $811,580; city pipe system, $6,000,000; personal property, $977,260; total, $10,844,840. The company asks that the city pipe system item be reduced to $4,119,298, and that the assessment of its personal property be lowered to $111,763. It was assessed last year for $10,774,[illegible], the items being: Real estate, $3,365,800; improvements, $[illegible]874,768; personal property, $333,885; franchise, $2,500,000. Under the new tax system franchises are assessed by the State Board of Equalization only, the company says in its application, and this board, against the company's protest, fixed the value of the Spring Valley franchise for the purpose of taxation this year at $3,619,600. The company will have to pay the State $36,196 on this franchise alone.

INCORPORATIONS.

SACRAMENTO, CAL.—The Citizens Light & Power Company has been incorporated with $2,000,000 preferred and $3,000,000 common stock and authorized to make a bond issue of $2,500,000.

SAN BERNARDINO, CAL.—Amended articles of incorporation of the East Redlands Water Company have been filed, capital $100,000; place of business, Redlands. The original incorporators were H. L. Drew, Lewis Jacobs, H. M. Barton.

LOS ANGELES, CAL.—The Glendora Independent Water Company has been incorporated with a capital stock of $200,000, subscribed $300. The incorporators are W. G. Hall, A. E. Englehardt and L. J. Goff.

LOS ANGELES, CAL.—The Baldwin Park Water Company has been incorporated with a capital stock of $100,000, subscribed $5000. The incorporators are Wm. Stevenson, W. H. Townsend, Solon Newton, C. H. Angel and J. C. DeMandel.

ILLUMINATION.

KENNET, CAL.—The Sacramento Valley Power Company has applied to the Board of Trustees of the city of Kennet for a franchise.

SUMAS, WASH.—The citizens of Sumas have decided to take advantage of the offer of the British Columbia Electric Company to furnish electric power and light to the town of Sumas.

FORT MASON, CAL.—Sealed proposals in triplicate for furnishing all material and labor and installing an electric lighting system at Fort Miley, Cal. were received here up to August 3, 1911.

SACRAMENTO, CAL.—J. Frank Robinson, cashier of the Sacramento Electric, Gas & Railway Company, has made the definite statement that the company will build a new home on SE. Eleventh and K streets. The property was purchased several weeks ago by Geo. H. Rand of San Francisco.

SANTA MARIA, CAL.—The Board of Supervisors has granted a franchise to lay pipes and sell gas in the county to R. E. Easton and others, representing the Santa Maria Gas Company, for $100. They will extend the mains from Santa Maria to Nipomo and Arroyo Grande, then to San Luis Obispo.

MERCED, CAL.—Mr. Walthal, commercial agent for the San Joaquin Light & Power Company, has been in Merced and gave out the information that a new gas rate had been made by his company to go into effect at an early date. New mains are to be extended to new houses as fast as constructed. A large number of the old mains are to be regraded.

MILL VALLEY, CAL.—The Mill Valley Gas & Electric Company, recently incorporated, has applied to the town trustees for a franchise to lay mains in the streets of the town and will install a $100,000 gas plant to supply Sausalito and this place with gas. The directors of this company are Dr. Ferdinand Butterfield, E. de Los Magee and J. Schlingmann.

SAN BERNARDINO, CAL.—The Board of Supervisors has sold a blanket gas main franchise covering all county highways in this county, except a small area previously covered in the city, to the Southern California Gas Co. Work is to be started within four months and to be completed within three years. The central distributing plant will be constructed in this city with radiating laterals to many points in the valley.

RICHMOND, CAL.—The contract for sinking the gas well at Richmond and Tunnel avenues in this city, has been let to D. S. Valentine of Oil Center. He will bring his machinery here at once to start work. The derrick, 80 feet high, has already been erected by the company. Valentine is to drill 2000 feet, and at this depth, if the indications are right and the best flow has not been struck, additional machinery will be

installed and the well will go down perhaps another thousand feet. John Nicholl, J. R. Nystrom, Contractor Cruickshank and other local men are financing the project.

TRANSMISSION.

LOS ANGELES, CAL.—Instructions have been given by the Board of Supervisors for the installation of an electric power line between the Kern River station of the Pacific Light & Power Company, near Eastlake park and the county hospital, to utilize the 50 h.p. due the county from that corporation.

TUCSON, ARIZ.—H. A. Smith has taken steps toward the establishment of a big power and irrigation project near Noria, Sonora, which will furnish power to four mines and smelters and the town of Llano and water for irrigation of 15,000 acres. A reservoir site near Noria has been selected. A flour mill is also in contemplation for Llano. Engineers are at work on the project.

LOS ANGELES, CAL.—Henry C. Huntington, W. G. Kerckhoff and A. C. Balch have launched an electrical power enterprise, with headquarters in Los Angeles, which will control practically all electric power in the San Joaquin Valley south of Fresno and a large percentage of that to be used in Southern California. The deal involves an ultimate bond issue of between $40,000,000 and $50,000,000; and the construction of one of the largest hydroelectric power plants in the world.

RENO, NEV.—The work of surveying for the construction of the new power and light plant which is planned to be built east of this city, is going on rapidly. The men behind the company are keeping their identity from the public, but have a number of men employed. The work of actual construction will soon commence. The company has secured former City Electrician W. E. Caffrey of Reno as its chief electrician, and he will supervise the construction of the plant. He says that it will be the largest on the Truckee River when completed, and will develop 5000 h.p.

FRESNO, CAL.—According to G. O. Newman, chief engineer of the Pacific Light & Power and the San Joaquin Light & Power Companies, who has come here after an inspection of the site of the proposed hydroelectric plant at Big Creek, near Shaver, that establishment will supply power both around San Francisco Bay and in the Los Angeles district. "The Big Creek plant will be the largest of its kind in the United States," said Newman, "and will develop, when completed, power representing 300,000 h. p. It will supply power for a great distance both around San Francisco and around Los Angeles. We control nine plants now in this State and in Arizona, and could use more power even now. The site is an ideal one for that purpose."

FRESNO, CAL.—The first link in the chain of power lines and sub-stations that will give Bakersfield and the West Side oil towns additional and far more adequate power facilities, generated at the Crane Valley plant of the San Joaquin Light & Power Company, is to be completed and the high tension will be put on the Moron line out of Bakersfield. In a few more days, the Bakersfield transmission line from Crane Valley will be cut in, and the big system will be working. The Coalinga power line, which now runs out from Fresno to the oil city by way of Hanford, is to be cut out for a few hours, to put in connections at the Henrietta sub-stations, west of Lemoore, with the Bakersfield line. When the Bakersfield line is in operation, this Henrietta station will tap it and furnish power in one direction to Hanford and in the other to Coalinga. The survey of the line to be run out over the west side by way of Dos Palos, Los Banos and Gustine is just completed, and the surveyor's figures were submitted. Material is being assembled for the work of constructing this line, and the actual work will begin in the course of the week.

TRANSPORTATION.

SEBASTOPOL, CAL.—The Board of Trustees has granted to the Petaluma & Santa Rosa Railway Company for a period of 50 years, a franchise to construct a standard gauge electric railroad within the town of Sebastopol.

SANTA ROSA, CAL.—Actual work of construction on the Santa Rosa and Clear Lake Railroad will be begun here within 15 days. The construction will begin at the city limits of Santa Rosa, and J. W. Barrows, who is a roadmaster with the Western Pacific railroad at Horncut, will come here and take charge of the construction work. The road will be run out by Burke's Sanitorium, Mark West Springs, the Petrified Forest and by Kellogg, at the site of the proposed Manual Training School, to be established by the State. From there it will enter Lake County and tap many of the principal springs and watering places of that county, while it will also reach Middletown, Lower Lake and Lakeport. The road is to be a narrow gauge, and either gasoline motors or electricity will be used as motive power.

STOCKTON, CAL.—With the announcement that the Tidewater and Southern Electric Railway, which is being built between Stockton and Turlock via Modesto, will begin operations in October, the statement was also given out of the general office yesterday that negotiations are pending with the Western Pacific to lease the track of that line from Ortega, on the old Tesla line, to the water front in Stockton. This will make it possible to make freight shipments from as far south as Turlock to this point and thence via water to San Francisco, establishing an entirely new transportation line from valley points to the bay city. Another consignment of rails for the new road is due to reach French Camp in a few days. Grading is being rushed, and, as the road runs through a comparatively level country, this part of the work will soon be completed. The steel bridge across the Stanislaus River is also well under way.

STOCKTON, CAL.—Contrary to report emanating from San Francisco, to the effect that the Western Pacific may purchase the San Joaquin Valley Electric Railroad as an entering wedge into the valley, Morris L. Brackett declares the electric line will be completed as planned and will not be converted into a steam road. It was intimated that there was a probability that the Western Pacific will use the electric line as a feeder, but will not operate steam trains over the rails. The San Joaquin Valley Electric Company is now operating at Modesto, having transferred its operations from French Camp to that city in order to hold its franchise. The fact that the Stockton-Modesto road is to use a mile and a fifth of the Western Pacific's tracks, indicates that there may be some agreement between the two lines. Mr. Brackett states that the electric line will use the old coal road tracks from the southern limits of the city to the intersection with the Southern Pacific.

TELEPHONE AND TELEGRAPH.

NAPA, CAL.—The Board of Supervisors has passed an ordinance granting a franchise to W. M. Lyons, for a period of 50 years, to erect telephone lines in the county of Napa.

SALT LAKE CITY, Utah.—At a meeting of the directors of the Rocky Mountain Bell Telephone Company a consolidation was effected with the Colorado Telephone Company and the Tri-State Telephone & Telegraph Company. The new corporation is to be henceforth known as the Mountain States Telephone & Telegraph Company.

SAN FRANCISCO, CAL.—Mr. Cobbe, head of the Pacific Telephone & Telegraph Company's engineering department with offices in the New Montgomery Street Exchange, has awarded the contract for the construction of the new building for the company in Spokane to H. J. Skinner of that city on his bid of $98,000. The structure will be of the class-A type and will house the company's main office in Spokane. The

plans for a three-story and basement brick structure for the same purposes, which is to be erected in Los Angeles, are complete and figures for the construction are being taken. The Los Angeles work will cost about $35,000. The next building which will come up for figures will be the Fresno exchange.

WATERWORKS.

GLADSTONE, ORE.—This place will vote on a bond issue of $20,000 for the construction of a water system.

OCEAN PARK, CAL.—Joe Shatuck of Los Angeles, who has the contract for laying water mains for the municipal water plant, under the recent bond issue, will commence work at once.

YERINGTON, NEV.—The Council has passed a resolution authorizing the Mayor and Clerk to sign up an agreement with Engineer Green to begin surveys for a municipal water system as soon as possible.

PRESCOTT, ARIZ.—The business men of the city have begun a well organized effort to secure a better and less expense water supply for the city. The council has been asked to appropriate a sum for drilling an experimental well.

SPOKANE, WASH.—Plans have been ordered prepared by Commissioner Fassett for laying a new main line into the north hill district from the up-river pumping station at a cost of $130,000 for the relief of the north Hill water shortage.

RIVERSIDE, CAL.—The committee appointed by the Mayor to investigate the matter of municipal ownership of the water system, reported in favor of the purchase of the Riverside Water Company, the Artesia and Kees plants. The estimated cost of the proposed purchase is $850,000.

ELMA, WASH.—The water ordinances providing for the issuance of $10,000 in bonds for the extension of the waterworks system and for a special election to be held on July 26th, to give the citizens an opportunity to reject or accept the issue, has been passed by the council.

LOS ANGELES, CAL.—Workmen are now clearing and improving the Tejunga orange site in San Fernando valley, recently placed on the market by George C. Peckham Company. Large pipes will be used for conveying water to this land from a canyon three miles away. The contract for concrete pipe for irrigating the land has been awarded at $6500. Plans are being prepared for a concrete reservoir with 228,000 gallon capacity.

RICHMOND, CAL.—The United Properties Company is beginning to turn its attention toward Richmond and take up its plans for development here. The survey for the double tracking of the electric railroad from the county line has been completed as far as Twenty-third street and Macdonald avenue and will be carried along Macdonald avenue to the Santa Fe station. As soon as Ashland avenue, the big, new connecting thoroughfare, is completed, the line will be double tracked across it and extended to the Standard Oil works, now reached by a single track.

SAN FRANCISCO, CAL.—Just as the city is about to close the option with William Ham Hall and the Tuolumne Water Supply Company and acquire the Cherry Creek water rights and properties of the Lake Eleanor system for $652,000 an effectual block to the transaction is applied with the filing of a suit to quiet title to the properties in question by the National Park Electric Power Co. The suit has been brought in Sonora, county seat of Tuolumne County, and names the city and county of San Francisco as co-defendants with William Ham Hall and the Tuolumne company. The National Park Electric Power Company claims prior title to all of Hall's claims in Cherry Creek. Judge J. P. O'Brien and Milton S. Hamilton are the attorneys for the National Park Company. In discussing the suit Judge O'Brien declared that the rights of the National Park Company include all of the rights which are offered to the city by Hall. The suit is merely a case to quiet title to the properties and in itself will not act as an injunction restraining the payment of the $652,000 to Hall and his company, but it is expected that a taxpayers' suit will be filed to effect such an injunction.

SUMAS, WASH.—This city has made a 10-year contract with the British Columbia Electric Railway Company, or its subsidiary power concern, for furnishing power to the city of Sumas, as the result of a recent election in that town. The company will merely furnish the current, the power and lighting question within the city of Sumas being entirely in the hands of a civic body appointed for the purpose. This incident is of interest as it is stated to be the first time that the British Columbia Electric Railway Company has supplied power without the borders of the Dominion and in view of the agreement between the United States and Canada regarding transmission of power across the border.

SAN FRANCISCO, CAL.—Plans have been prepared by the Pacific Gas & Electric Company to develop an additional 71,000 hydroelectric horsepower at a cost of about $10,000,000. The additional capacity will bring the company's total horsepower up to 260,000, including steam plants of over 96,000 horsepower. The company now serves about 33,000 square miles in Central California and has about 1100 miles of high transmission lines. The plans provide for the erection of a dam in the canyon of the South Yuba River, which will increase the present water storage from fifteen lakes in Nevada and Placer counties by 2,500,000,000 cubic feet. Two plants will be constructed: the first, having a head of 1647 feet, will develop 50,000 horsepower; the second, which will use the water again, will have a fall of 750 feet with a capacity of 21,000 horsepower. The overflow of water is then used for irrigation purposes.

ALPHABETICAL INDEX TO ADVERTISERS

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JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXV | SAN FRANCISCO [illegible] | NUMBER [illegible]

UNITED RAILROADS' ABANDONMENT OF STEAM

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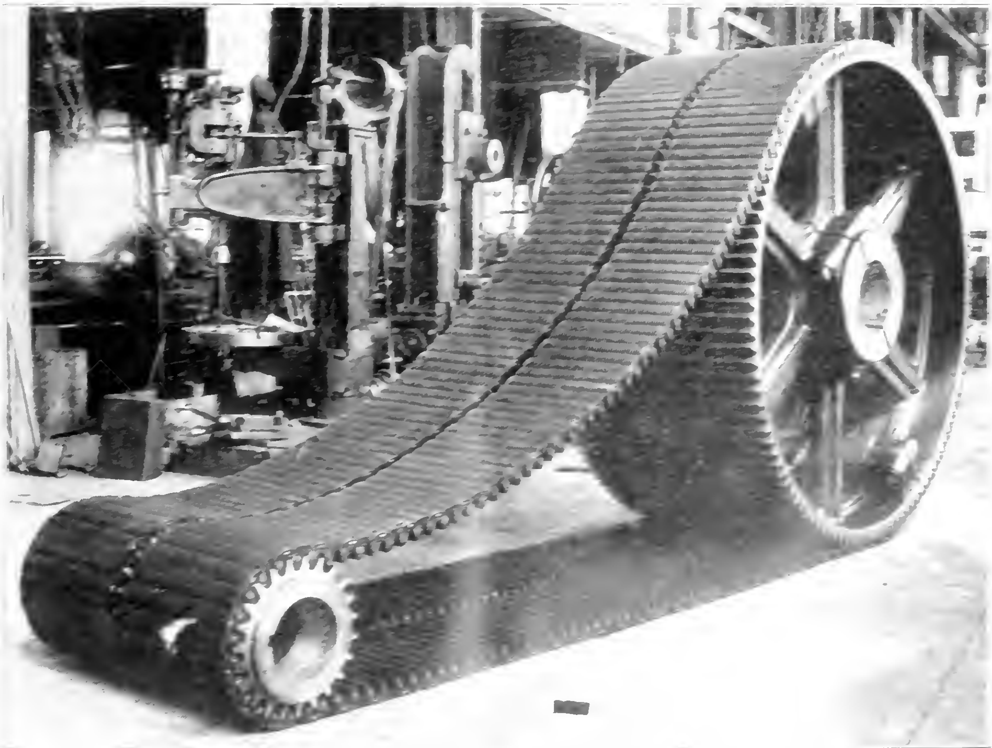

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gines coupled to the same main shaft, each engine having 250 horsepower, making a total of 500 horsepower. The friction load of the cable and road machinery, with no cars on the line, amounted to 320 h.p. The friction load of the engine itself including cylinders, shafting, fly wheel, gears, pinions and winders, amounted to 40 h.p. Operating conditions require that the plant run continuously for 20 hours and 14 minutes per day, year in and year out. In order to bring the engines to a stop in case of emergency, the fly wheel—16 ft. in diameter and weighing 22 tons—was equipped with a hand operated band brake acting on about 1/3 of the circumference.

In designing the motor to replace these engines the operating conditions above described had to be met in every particular. In addition, to allow for repairs to the cables it was necessary that the motor be capable of being operated in either direction at half speed as well as full speed, under full load. It was required that the motor run for 1½ hour at the former speed. A constant rope speed of 9.451 miles per hour with the absolute minimum of variation, was imperative. In order to save the high cost of converting machinery, alternating current was specified, this form of power being the most available at this location.

The first serious problem encountered, after the preliminary investigations were complete, was that of transmission. In order to leave adequate space for making repairs to the cables, the smallest motor available was necessary. The bulk and high cost of a slow speed motor made its use practically impossible; on the other hand, a high speed motor required a very large speed reduction. All the ordinary methods of transmission, such as belts and ropes, were found to be impracticable under the required conditions. After exhaustive investigations the field narrowed down to two methods—either a gear or a chain drive. Finally, on account of its noiselessness, low maintenance cost and high efficiency, a Morse chain was chosen.

The installation as shown in Fig. 2 consists of one General Electric 1-18-600 h.p.-400 r.p.m.-400 volts, Form M, induction motor, with master controller and contactors, and a set of 12 cast iron grid rheostats,

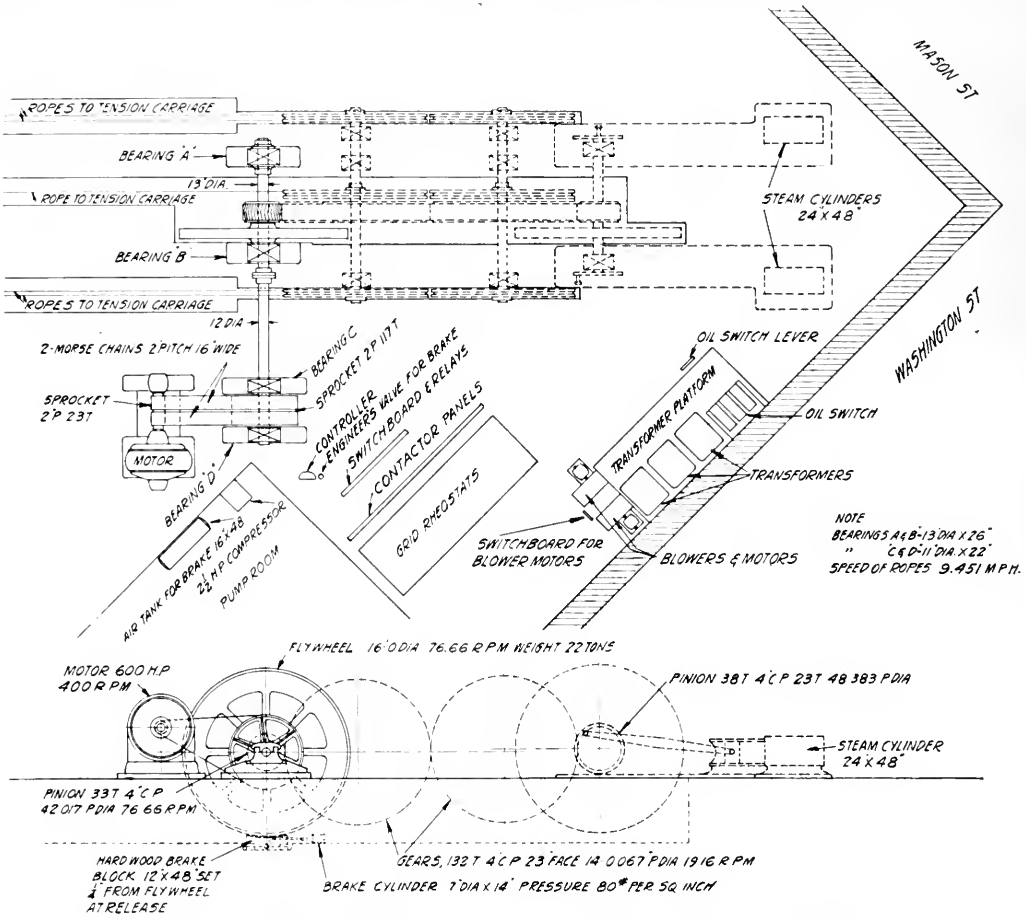

Fig. 2. Floor Plan and Elevation of Washington and Mason Street Power House. Dotted Lines Show Old Work. Solid Lines Show New Work Required by Motor Drive.

the motor being mounted on a sliding base for adjustment of the transmission chain. Power is brought to the building at 11,000 volts, passing through a set of air cooled step-down transformers which reduce it to 440 volts. These transformers were taken from the sub-station at Turk and Fillmore streets, where they were used previous to the installation of modern motor generator sets at that point. They are cooled by two Sirocco No. 4 fans, each fan being operated by a G.E. 440 volt 1½ h.p. a.c. motor. These fans and part of the switchboard equipment are the only new material used on this part of the work.

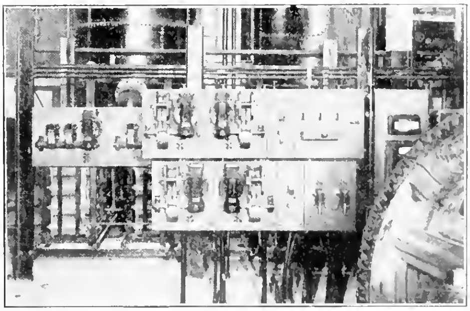

Fig. 3. Front View of Relays, Switchboard, Contactors and Cast Iron Grid Resistance.

The motor shaft carries the sprocket for the Morse chain; this sprocket contains 23 teeth, is 15.04 in. in diameter, with 34 in. face, made of semi-steel. The transmission link consists of two Morse Silent Chains, each 16 ft. wide, with 2 in. pitch. This drives a sprocket on the main shaft having an outside diameter of 74.87 in. with 117 teeth, giving a speed reduction of approximately 5 to 1. This chain is the largest on the Pacific Coast and the second largest in the world. In addition to the high speed ratio, the distance between sprocket centres 10 ft.—is unusually small.

The large sprocket drives a main shaft carrying a herring bone pinion 42 in. pitch diameter, 4 in. circular pitch, 33 teeth, which meshes into the twin gears of the winders. These gears have a pitch diameter of 14 ft., with 132 teeth. On the same shafts with these gears are the winders which carry the cable. The winders have a diameter varying from 13 ft. 9 in. to 13 ft. 6 in. due to the wear on the wooden lining of the grooves. The main shaft carries a fly wheel 16 ft. in diameter weighing 22 tons, which is a duplicate of the fly wheel used by the steam plant. This fly wheel is acted on directly by a specially designed air brake, shown in Fig. 5. All the foregoing equipment, with the exception of the motor, chain and sprockets, was second-hand, being part of the original plant or taken from abandoned plants owned by the company.

The brake consists of a hardwood block 4 ft. long and 12 in. wide, cut to the same radius as the fly wheel, having a minimum thickness of 12 in. This block, when in action, bears directly against the face of the fly wheel, being actuated by an eccentric lever connected to an air cylinder. The air cylinder carries a pressure of 80 lbs. per square inch, with a diameter of 7 in., giving a pressure on the brake lever of 3078 lbs.; as the levers have a ratio of at least 12 to 1, this

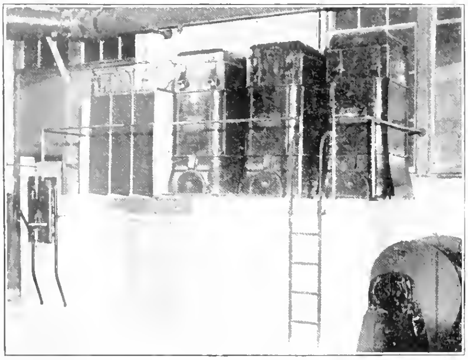

Fig. 4. Transformer Gallery Showing Oil Switches, Operating Lever and Blowers.

gives a braking pressure at the rim of the fly wheel of 37,000 lbs. By actual test this brake has brought the cable to a full stop in 12 seconds. The best time obtainable with the hand brake was 20 seconds. This is of great service in catching a broken strand before it gets out of the power house. All the air equipment described is identical with that used on the electric cars of the company, the brake being applied through an ordinary engineer's valve located beside the controller.

To allow for emergencies the steam engines are held in reserve, it being possible to disconnect the motor by throwing out the 33 tooth pinion and to connect the engines by throwing in a similar pinion at the steam end.

In operating the steam plant the cost per rated engine h.p. hour was 64 mills. With the electric plant the cost per rated motor h.p. hour is 58 mills. The comparative cost of lubrication cannot as yet be accurately determined, as the motor has not been in operation for a sufficient time, but a considerable saving in favor of the motor is expected.

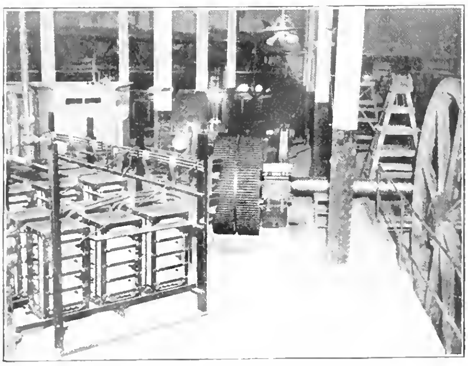

Fig. 5. General View of Motor, Morse Chain, and Driving Sprocket. The Motor Shown has by Actual Test Brought the Cable Ropes from Complete Rest to Full Speed in 40 Seconds.

On account of the more uniform speed of the motor, the wear on the rope has been greatly reduced and its life correspondingly lengthened. The same is

true of the wear on the grips. The steam engine, under a sudden increase of load, used to speed up and literally "chase" the cable until the governor acted, producing the surging and jerking of the cable that proved the chief objection to this form of traction.

The constant speed of the motor has several advantages in addition to those of a purely economic nature. The smooth operation has added greatly to the comfort of travel on the cable lines, has permitted a more rapid service and has enabled the cars to maintain the exact schedule during rush hours—a thing hitherto impossible.

out trouble, bringing the ropes from complete rest to full speed in 40 seconds.

The motor drives the entire cable system operating on Powell, Mason, Clay, Sacramento, Washington and Jackson streets. This consists of five 1¼ in. wire ropes of variable lengths, having a total length of 12.26 miles, with a net weight of 162 tons, operating a maximum of 32 cars.

We are indebted for the information contained in this article to B. P. Legare, engineer of maintenance of way and construction for the United Railroads. The entire layout was designed and installed by W. B. Farlow, chief draughtsman of the department of maintenance of way and construction.

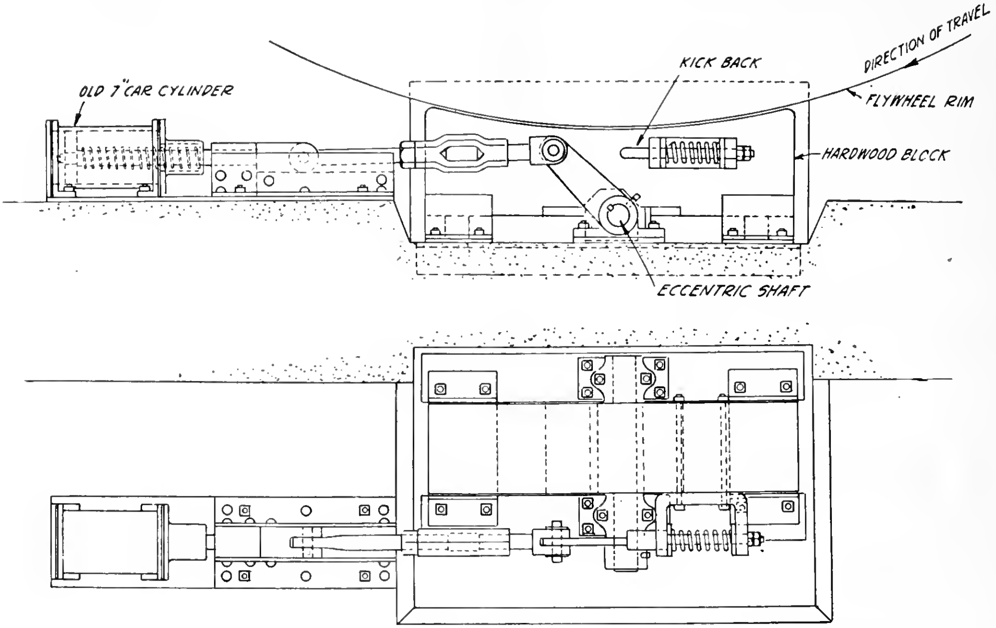

Fig. 6. View of Friction Clutch. But Twelve Seconds Required to Bring System to Standstill.

In excavating for the foundations of the main driving shaft of the motor plant the brick foundations and anchor bolts of the original vertical engines were encountered. As they were in excellent condition new threads were cut on the old bolts and collars fitted over them, which in turn engaged the anchor bolts of the shaft bearings. The collars and bolts were then embedded in concrete, forming a very satisfactory foundation.

For the first two days of motor operation the steam plant was not disconnected, for fear of a break down. This added to the ordinary load on the motor, the entire friction load of the steam plant with its fly wheel and gears, as well as considerable resistance due to the back pressure of air in the cylinders. In spite of this handicap the electric plant worked with complete smoothness from the start. After about three weeks operation the plant was shut down for 10 minutes at 3 o'clock in the afternoon to permit lubrication experts to examine the chain. This made it necessary for the motor to start the entire system, under full load, from a dead stop. It accomplished this feat with-

ENGINEERING APPLICATION OF BAMBOO WOOD.

In Java the Government engineers have recently constructed a road bridge, more than 100 feet long, with a central span of over 60 feet, entirely of bamboo. The road bed is composed of bamboo matting, which will be covered with a layer of dry earth. In profile the bridge resembles a steel structure, but all the members are bamboo rods. It is estimated that such a bridge should be good for 10 or 15 years. There are two kinds of bamboo used in building and cabinet-making in the East—one having solid and the other hollow stems. The solid, seen in Japanese furniture, is much smaller than the hollow, but both belong to the same species. In the construction of bamboo houses no nails are used. The parts are bound together with lashings formed from the skin of the bamboo itself.

NECESSARY AMENDMENTS TO MINERAL LAWS.[1]

BY G. O. SMITH.[2]

The increasing share which the United States Geological Survey has been asked to take in the public land administration by the Interior Department has brought many of the problems connected with the public land laws more directly to the attention of those charged with the work of this bureau. For over thirty years, however, these problems have interested the Survey geologists who have had exceptional opportunities for first-hand observation in nearly all the important mining districts of the country, and for almost as long a period the engineers of the Survey have been in touch with the irrigation and power developments in the public land States. This intimate experience with both field conditions and administrative problems justifies an expression of opinion which may be appropriate to this occasion.

The objects to be sought by amendment of the public land laws are, first, purposeful and economical development of resources for which there is present demand with retention of such control as may insure against unnecessary waste or excessive charges to the consumer, and second, the reservation of title in the people of all resources the utilization of which is conjectural, or the need of which at least is not immediate. The means that are essential to the attainment of these objects are, first, the classification of the public lands, second the separation of surface and mineral rights, and third, the disposition of the lands on terms that will secure the highest use, enforce development and protect the public interest. Legislation based on these principles will not only secure the positive benefits of immediate utilization but will also avoid the evils of speculative holdings of lands by fictitious use or by admitted nonuse, for the future enjoyment of the unearned increment or of the profits of monopolization. With actual development made a condition of possession, and with land classification and separation of estates made preliminaries of disposition, the present day utilization by individuals or corporations and the reservation to the people for future use become at once possible without conflict of interests.

The classification of the public land is essential to the administration of not only such laws as express the principle of separation but also of those whose purpose is to promote the highest use of the land. Land classification is first of all the determination of the best use to which each particular portion of the public domain can be put, and by the organic act of March 3, 1879, this duty was specifically imposed upon the Director of the Geological Survey.

Under the withdrawal act of June 25, 1910, classification is made possible in advance of disposition and disposition can be postponed to await needed legislation.

The second step, both in principle and practice, appears to be that of making possible by legislation the separation of surface and mineral rights whenever the two estates have values which can be separately utilized. A notable advance in public land legislation was the passage of the acts of March 3, 1909, and June 22, 1910, which provide that patents issued thereunder grant title to the surface of the land only and thus permit the agricultural development while at the same time the United States retains title to the underlying coal deposits.

On the subject of waterpower legislation the position of the Geological Survey is essentially that set forth in January of this year in a report addressed to the Secretaries of the Interior and of Agriculture by a joint committee representing the two Departments. The legislation there outlined would provide for lease of public and reserved lands of the United States valuable for waterpower development for a fixed term, not to exceed 50 years, with moderate charges for use and occupancy of the land, and revocable only upon breach of conditions or on account of the charge of excessive rates to consumers. These leases should be identical in terms, whatever the Department under which they are granted, with joint and uniform regulations governing all matters relating to waterpower development of land belonging to the United States. Provision should also be made for periodic and equitable readjustment of charges, transfer of lease, preferential rights to renewal, and compensation for improvements at the termination of the leasehold. The law should specifically recognize waterpower use as dominant and both insure to the lessee undisturbed occupancy of the land needed for such use and reserve for future utilization all the land believed to possess value for waterpower development, these lands to be designated by the President but to be open to other entry subject to this reserved right wherever separation of the waterpower use and other use is possible.

The chief advantage of land withdrawal and classification lies in the essential relation to the principle of proper disposition of the public domain, the real purpose of public land administration being to secure such reservation or disposal of the people's land as will assure its highest use. The question of amendment of the present laws relating to the disposition of coal, oil, gas, and phosphate deposits on the public domain is recognized as fairly before the public by the specific mention of these minerals in the Withdrawal Act.

The coal land law is unquestionably the most satisfactory of the present mineral land laws in that it admits of the placing of an adequate valuation upon the deposits, and in the administration of this law the purpose is not only to base the appraisal price upon the quantity and quality of the coal present and to give consideration to every known physical and commercial factor affecting the value of the deposits but also to make the selling price approach as nearly as possible the present purchase of a royalty under a leasehold. Thereby it is intended to permit purchase for immediate development and at the same time to prevent or at least discourage purchase for long-time investment or for monopolization. So many factors, however, require consideration that an ideal adjustment of the values is well nigh unattainable for many if not for most coal lands, and on this account a strong argument may be made for support of the lease over

[1]Abstracted from an address at the Twenty-first Anniversary of the Michigan School of Mines, Houghton, Mich., August 9, 1911.

[2]Director of U. S. G. S.

the sale system. Under leasehold it would be comparatively easy so to adjust the relationship between ground rental and royalty as to prevent the acquisition of coal deposits until such time as their development should be profitable. On the other hand, it is possible, under the present law, and it is the policy in its administration, to readjust the prices from time to time, either by reduction to encourage development in special cases or, more commonly, by raising the price on account of increased value due to new discoveries or to changed commercial conditions. Hardly less important, moreover, is the better control possible under a lease system, although against the advantage of such control must be weighed the cost of Federal management and the possibilities of inefficient administration or even maladministration. The present coal land law, however, has one serious defect, which should be remedied if a leasing law is not enacted. The restriction of area that may legally be acquired to a maximum of 160 acres for an individual and 640 acres for an association is not in accord with good mining practice. The fixed charges on the cost of a modern coal mine, provided with the up-to-date equipment necessary to conserve life and property and to assure maximum recovery are too high to be assessed against the tonnage of so limited a tract, especially if the coal seam is of moderate thickness. A law designed to promote the practical utilization of coal deposits, whether the system contemplates sale or lease, must provide for the holding of a large enough unit to permit the opening and equipment of a modern mine and to warrant its operation on an economical scale. Without such provision for commercial operation too great an advantage is secured to the land-grant railroads and large coal companies already in possession of considerable areas of high-grade coal.

The most urgent need of legislation for the disposition of mineral deposits is in the case of oil and gas. It is most apparent that the placer law, which is none too well adapted to meet modern conditions in mining placer gold, is wholly inadequate as a method of dealing with public oil lands, inasmuch as the discovery of oil is a late stage in the exploration and development of the land claimed under the law. Thus, large expenditures, extending over several months, if not years, are necessary before any right is acquired against the Government, and during all this time there is lacking any legal protection of the oil prospector against unscrupulous claimants or competitors better backed by capital. The need for remedial oil legislation is somewhat less acute than it was a year ago, by reason of the passage of the act approved March 2, 1911, the effect of which is to validate a class of claims which, while clouded by the construction which the Department was forced to place upon the misfit placer law, under which title to oil lands must now be made, were bona fide in that the inception of their development antedated the oil land withdrawals. This enactment was in accord with the spirit of the withdrawal act, which provides for the protection of equities already established.

The need for a better law is, however, imperative and the legislative action demanded by the situation should not be limited to an attempt to revamp the general placer law but should be the enactment of an altogether new measure, especially adapted to provide for the sane and equitable development of this industry in the future. First, the new law should authorize the issue of exploratory permits, granting to individuals or associations the exclusive privilege of occupation, the sole condition of such a grant being diligent and adequate prosecution of development work, measured by the expenditure of fixed sums within certain periods, with possibly the payment of a small fee to the Government in lieu of such expenditure during the first six months. The issue of this permit should preferably be limited to one to each citizen or association of citizens, although after the lapse or surrender of such a permit the former holder should be allowed to again apply for an exploratory permit. In the second place, the law should provide that upon discovery, the holder of the permit be given a leasehold title with a royalty varied to meet local and actual conditions. The "wild-catter," or prospector in unproved country, whether such unproved territory is classified on geological evidence as oil land or not, should be given special privilege to offset his greater risk. This privilege might take the form of an increased acreage, held both under permit and under lease, or a practical exemption from the payment of royalty, merely a nominal rental being charged under the lease. The chief advantage of the leasehold for oil over a fee simple title lies in the prevention of monopolization through large holdings. Such large holdings without production would be guarded against by a ground rental sufficiently high to discourage the acquisition of lands except for immediate and continued development, although provision should also be made in the lease for surrender under terms which would protect the Government. This indirect control of development would be preferable to the direct enforcement, by forfeiture, of continuous production, which should be avoided because of the danger of disturbing the delicate equilibrium between supply and demand. Transfers of interest, under either permit or lease, should be permitted because of the absolute necessity in most instances of securing capital for both drilling and operating an oil well. The law, however, should set forth the purpose of such control of transfer, which would be to provide protection for the original locators, most of them men of small means, and more especially to secure the prohibition of too large holdings of Government leases by big companies.

Whatever the details that may characterize this or that amendment to the public land laws, the essentials to be sought are development of those resources for which there is present need and the protection of the other resources for which there is no immediate demand. To this end the lawmakers in my opinion should concern themselves more in retaining such control as will prevent either nonuse on the one hand or waste on the other, than in devising means of increasing the public land receipts by heavy royalties on the producing coal mine or hydroelectric plant. Tax instead the idle property. Through the full development of the mineral industry, the nation can secure indirect benefits far in excess of any direct profits in the form of fees or rayalties.

TEST OF FIRE ALARM SYSTEM RECENTLY INSTALLED AT THE PRESIDIO HOSPITAL.

An automatic fire-alarm system has recently been installed at the Presidio Hospital. The installation covers practically all of the 39 government buildings in the hospital department as shown in Fig. 1.

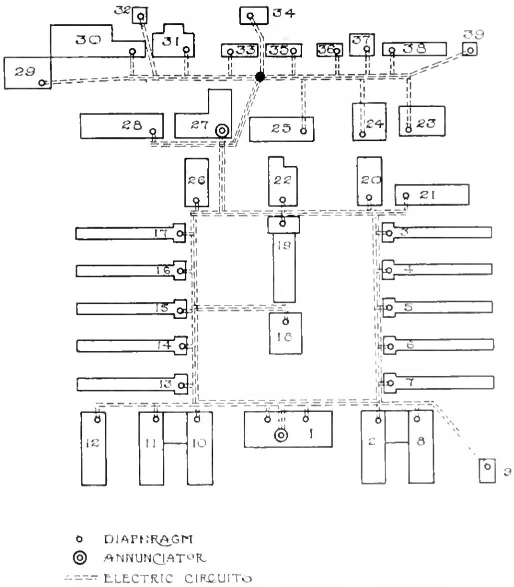

Fig. 1. Plan of Hospital Buildings at Presidio.

1. Administration Building (Main Alarm Station).
2 and 8. Barrack Quarters.
3, 4, 5, 6, 7. Wards.
9. Detention Ward.
10. Nurses' Quarters.
11. Post Exchange.
12. New Officers' Ward.
13, 14, 15, 16, 17, 20. Wards.
18. Operating Room.
19. Dining Room.
21. Electric Laboratory.
22. Kitchen and Store House.
23. Main Detention Ward.
24. Detention Ward.
25. Laundry.
26. Patients' Store House.
27. Power House (Main Alarm Station).
28. General Store House.
29, 30, 32. Stables.
31. Carpenter Shop.
34, 35, 36, 37, 38, 39. Store Houses.
33. Shops.

The system consists of small tubing encircling the ceiling of each room and also beneath the flooring and between the ceiling and roof. Within the 39 buildings equipped with the tubing, there are 55 separate circuits, each circuit covering a certain part of a building. An alarm bell is placed in an accessible place in each building which continuously rings in case of fire. Simultaneously an alarm is sounded in two main centers, which are the administration building and the power house. In these two buildings are placed a large 70 drop annunciator, designating the exact location of fire. At the same time a register tape registers the building on fire, while a large 10 in. gong strikes the number of building ringing in. One of these gongs is placed outside of the administration building, in order for everybody to hear the alarm. The source of power used in operating this system is

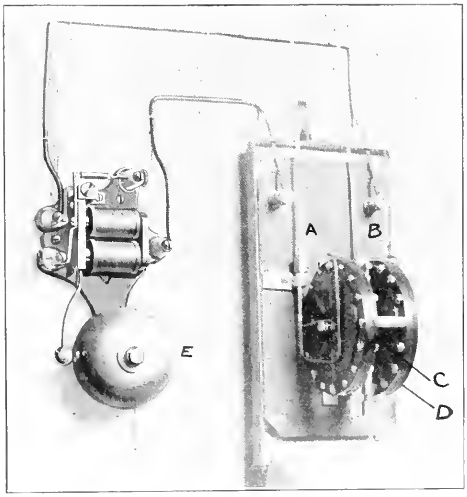

Fig. 2. Bell and Diaphragm for Fire Alarm.

by means of storage batteries, having two sets of batteries, with battery board to operate same, while one is in use, the other is on charge. By such arrangement there is always sufficient power to operate the system.

Fig. 3. Igniting Fire for Testing System.

The alarm operates by utilizing the expansion of air, due to heat, in a small tubing which is distributed on the ceilings of the risk to be protected. The

ends A and B of the tubing which has encircled a room to be protected, are connected to metal diaphrams C and D (see Fig. 2). Any sudden rise of temperature at any point of this loop is quickly transmitted to the diaphrams. This causes an unbalanced condition with the air from without pressing against the other side of the diaphram. This pushing of the diaphram to one side closes an electric circuit which sounds the alarms. One salient feature of the installation is found in the fact that even though a tube becomes broken or shattered by means of the double diaphram arrangement the alarm is still sounded. As a sudden rise of temperaature is necessary to operate the alarm in order to cause the unbalanced condition at the diaphram, although the diaphram is sensitive to a very small unbalanced temperature, yet exceeedingly hot weather will not sound the alarm for the diaphram has the same pressure within as without.

During the past week a series of tests have been put through in order to thoroughly try out the system. Fig. 3 shows a can with alcohol just about to be ignited. By careful scrutiny the small wire tubing can just be distinguished on the ceiling above. A series of alarms were sent in from various buildings within 25 to 40 seconds after the ignition shown. A tube was then cut and the alarm came through, though a few seconds later. After this experiment a regular bonfire was built in the barracks under the direction the Colonel in charge, burning from all variations of a small fire to a large blaze. When it assumed dangerous proportions the alarm was promptly sounded. The installation has been under the personal supervision of Gregg Curtin, Pacific Coast Manager of the International Electric Protection Company of New York.

WORK NORTH OF GATUN LOCKS.

Work has been begun on a coffer-dam which will be built across the north end of the lower lock at Gatun to prevent water from entering the lock pit during the removal of an earthen dike, containing about 500,000 cubic yards of material, which now serves as the only barrier. The arrangement will also permit of an uninterrupted continuance of operations within the lock while the removal of the dike is in progress. The site of the dam will be at the caisson sill of the lock, and the structure will be built of sheet piling, caulked and battened, supported by concrete piers, 43 feet high and 18 inches thick, spaced 10 feet from center to center. It will be of sufficient strength to resist a 40-foot head of water, which is about the depth of the existing artificial basin, north of the locks. When the dam is completed, a suction dredge will be brought up the French canal and through a small channel connecting it with the basin, and set to work on the dike, the material being wasted to one side. When the dredge has finished operations, it will be removed, the open water channel closed, and the pit unwatered and cleaned out, after which, the work of constructing the approach wall can be started.

HOOP SYSTEM OF DELIVERING ORDERS.

The method of using hoops has been in use on transcontinental railway service for years. It has not, however, been in general use in electric service.

Superintendent F. A. Boutelle of the Puget Sound Electric Railway has found it most convenient in the issuing of orders to express or limited trains. The

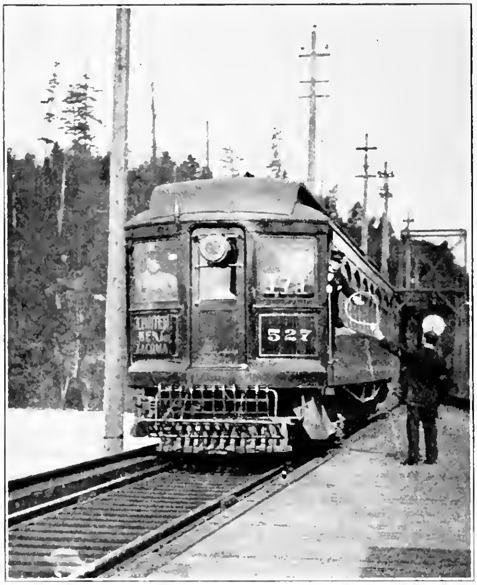

Fig. 1. Operation of Hoop System on Limited Trains.

hoop system as shown in the illustration of the limited between Kent and Tacoma, Wash., is used when orders are to be delivered, which do not require the signature of the conductor and motorman. In all orders, however, restricting the rights of trains, the motorman must stop his car and the crews sign the orders.

The hoops are made of very light wood and are held by the telegraph operator in a position where the conductor standing on the steps of his train can pass his arm through it and receives it in that manner. The stations are kept supplied with hoops by interchange—i. e. the conductor throws one off as he receives one from the operator.

BONUSES FOR MEMPHIS EMPLOYES.

On March 1, the Memphis Street Railway Company announced that all motormen and conductors who during the succeeding three months could show a clean record with no accidents or violations of rules should be awarded a bonus of one cent an hour. During the past three months the results have been satisfactory under this arrangement and the practice will be continued. The company has distributed $3500 among the employes, some of the crews having earned the bonus from the time the plan was inaugurated.

REDWOOD.

A recently published Agricultural Department bulletin by W. L. Hall and H. Maxwell on Uses of Commercial Woods of the United States, is of much interest to users of redwood.

Redwood has a dry weight of 26.2 pounds per cubic foot, a specific gravity of 0.42, ash 0.14 per cent dry weight of wood, a fuel value 57 per cent that of white oak, a breaking strength of 8000 pounds per square inch and a factor of stiffness equal to 1,140,000 pounds per square inch.

In character and quality it is light, soft, moderately strong, brittle, grain fine, even, straight, sometimes curly; annual rings wide in the young timber, summerwood thin, dark colored, hard, conspicuous; medullary rays numerous, very obscure; color light to dark red, the thin sapwood nearly white; splits and works easily and polishes well; very durable in contact with the soil.

In growth it reaches a height of 180 to 280 feet, occasionally over 300; diameter 6 to 10 feet, sometimes 15.

The redwood belt extends in a strip 500 miles long from southern Oregon to central California. The strip is narrow, ranging in width from 10 to 30 miles. The commercial range has been estimated to cover 3000 square miles, but the dense logging woods cover a much smaller area than that. The estimates of the merchantable stand vary. In 1880 the Federal census placed it at 25,825,000,000 feet. More than 20 years later, upon fuller information, private estimates doubled that amount, notwithstanding much cutting had been going on for years. The heaviest stand is near the center of the redwood region, in Humboldt County, Cal., though very dense forests exist both north and south of that point. It is not unusual for 50,000 feet to be cut from a single acre, and often three times that. Single trees of enormous contents have been reported, and it is probable that no other timber in this country can show larger yields per acre.

Mature trees attain an age of from 500 to 800 years. The oldest reported was 1373 years, so that redwood does not attain to the great age of the big tree of the Sierra Nevada Mountains. Redwood trunks 20 feet in diameter, with heights of 300 feet or more, have been measured, but the average is much under that, ranging between 6 and 10 feet. When a tree passes the age of 500 years it is liable to die at the top.

Redwood is one of the few soft woods that reproduces bountifully from sprouts. Few trees surpass it in that particular, and the vigor of the sprout growth is remarkable. A large portion of the forest is renewed in that way, and the largest trees retain their ability to send up shoots from the stumps.

The splendid redwood was inviting to the early settlers of the region, and they put to use as much of it as they needed. The Spaniards cut sparingly, because they wanted little. They were moderate users of lumber, and for their more pretentious buildings preferred adobe or unburned bricks. They found places for a few heavy beams in their churches and mission buildings, but the majority of these structures were in central and southern California outside the redwood belt, and very little redwood found place. The Russian settlers cut considerably more, but their total cuttings were not sufficiently extensive to make an impression upon the hundreds of square miles of that timber near the California and Oregon coasts.[1]

Settlements of Americans were planted very rapidly after the discovery of gold, and sawmills in the redwood region put in their appearance about 1850. Lumber was cut for houses, barns, fences, and other farm uses, and a small amount of it found its way to the mines, where it was made into sluice boxes, rockers, sheds, and other mining appliances and appurtenances. But the principal mining fields were not near the redwood forests, and the use of the wood by the placer miners was the exception rather than the rule. In some instances boats were made of it, but it was not esteemed for that purpose as highly as Port Orford cedar, which was abundant about Coos Bay in southwestern Oregon. The chief demand for redwood during the early years was as ranch material. The earliest operations by sawmills were south of San Francisco and immediately north of it. It is said that the first cargo of redwood shipped from the Humboldt Bay region was in 1855, though fir and pine were shipped from there earlier. The cargo amounted to 200,000 feet, and went to San Francisco. The earliest operators picked small redwood trees because their primitive mills could not manufacture those of large size. During the Civil War circular saws began to replace the muley saws of the pioneers, and large timber could be handled.

A redwood picket fence at Santa Cruz, Cal., was said to have remained sound 61 years, and in the vicinity of old Russian settlements fence posts are shown in fairly good condition which it is claimed were placed there almost a century ago. That is proof not only of the lasting property of the wood, but also indicates that it was a fence material at an early date. Pioneers put it to use also for poles, grapevine stakes, wharf piles, piers, and supports for bridges, and well curbs. Though the best of the wood resists decay many years on land or in fresh water, it offers little resistance in salt water when attacked by the teredo or other marine borers. The tannin or other acid which the wood contains is credited with rendering it immune from ravages of land insects and fungus, but salt water apparently leaches the substance out in a short time and leaves the wood defenseless. For that reason piles, wharves, cribs, piers, and sea walls built of redwood in early times have not survived in salt water as well as in fresh.

In 1902 the Southern Pacific Railroad had in its tracks west of El Paso 12,000,000 redwood ties. That was twice as many as the ties of all other woods combined. Where the traffic is moderate, and where plates are used between the rails and the wood, these ties last 8 to 10 years. If plates are not used the iron rails cut them rapidly. In most cases a redwood tie wears out before decay renders it useless. Where traffic is

[1] Documentary evidence of the Russians' activity in cutting redwood is not abundant but numerous sawpits and stumps evidently cut long ago about Fort Ross and Bodega Bay are said to date from the days when the Muscovites in California manufactured redwood lumber with whipsaws.—"Souvenir Humboldt County," California, p. 3.

light, as on side tracks and switches, the wood gives service two or three times as long as in main lines. Instances have been cited where redwood ties in California were in daily use for 25 or 30 years but in those cases mechanical wear was small.

The spike-holding properties of redwood are only fair. Softwoods are generally inferior to hardwoods in that respect, and redwood is in the class with average softwoods. The ties are not only extensively used in California and west of the Rocky Mountains, but they are found in considerable numbers in the railroads of Mexico, Peru, Chile, and even in India. One of the chief properties recommending this timber in some foreign countries is its immunity from attack by ants. The coloring substance in the wood is supposed to be the cause of it, and this timber is often, perhaps always, untouched where other timbers may be devoured. The advance in redwood prices in recent years has excluded it from some regions as a tie material.[1]

Railroads employ redwood for many purposes other than ties. It is an excellent culvert timber, because of its resistance to decay. For the same reason it goes into trestles and bridges in positions where strength is not the chief essential. In sheds, warehouses, and buildings of various kinds it is often selected for the foundation material, sills, sleepers, and pieces near the ground. It is used for car roofs, siding, and interiors. The characteristic which fits it specially for these purposes, is its small tendency to shrink or swell. This is important in freight-car material, which is liable to pass in a few days from dry summer heat to cold mountain rains or snows, or into fogs, and back again into dry airs. Redwood stands that test in a way highly satisfactory. It holds paint well, which lessens repair bills. Redwood in freight cars has given 20 years of service, a record that will compare well with that of any other wood.

The industries of the Pacific Coast, and in a lesser degree of the whole country, owe much to the good qualities of redwood as a material for tanks, vats, flumes, conduits, and other structures of that class. Railroad water stations in California, Arizona, and Nevada are well equipped with tanks of this wood. They are frequently a part of municipal waterworks. Eureka, Cal., some years ago built a tank 30 feet high, 54 feet in diameter, and with a capacity of about 584,000 gallons, and later added another of equal capacity. When redwood is first used for holding or conducting water the fluid is stained by the coloring matter leached from the wood, and the same result is seen when water flows from a new redwood roof. In a short time, however, the water clears and no unpleasant results follow.

The wine makers of California equip their cellars with redwood tanks for storage purposes. For this class of heavy cooperage it is one of the best obtainable materials. The density of the wood is sufficient to prevent leakage; the grain is straight, making it easy to work; it gives long service; and is not liable to be attacked by boring insects which sometimes riddle pine tanks. Tanners' vats of redwood last a long time, and the wood resists the action of tanning solutions. Redwood vats also meet the trying demands in cyanide plants where ores are separated.

Some of the finest, largest, and best-built wooden water pipes and conduits are of redwood. It meets requirements so well and in so many ways that large use of it is made hundreds and even thousands of miles from the source of supply. The staves are fitted and joined so accurately that leakage is little more than from iron, and it is claimed that the wood is so much smoother that a given pipe will carry more water than one of metal. This is particularly true after the two have been some years in use. The wood grows smoother by wear and the iron rougher by corrosion and accretions. Pipes from 8 inches to 9 or 10 feet in diameter are in use, and single pipes have been built 20 miles long. Redwood pipes and flumes of this kind have been constructed as parts of municipal water plants or of manufacturing concerns or mines in all portions of the United States. The staves are generally shipped ready manufactured, though some fitting is done on the ground. The pipes are bound with iron hoops. It is possible to carry such flumes across ravines or trestles, or under the ground, and if necessary they can rise above the level or sink below it like a siphon.

Brewers coat their redwood tanks with shellac on the inside to prevent direct contact with the wood. Such receptacles are widely used, not on the Pacific coast alone, but in Milwaukee, Chicago, Cincinnati, and other eastern and central cities.

Aqueducts and flumes in connection with irrigation canals are frequently of redwood. In that capacity redwood has figured perhaps more largely than any other timber in the development of irrigation in California. It has given much satisfaction in the construction of large outfall sewers, where resistance to decay is of much importance. Redwood water pipes, built of staves and banded with metal hoops, are used in many parts of the country.

Redwood gutters and eave troughs for houses are widely used, not only in California, but in distant regions.

Redwood has long had the reputation of being one of the slowest woods to burn, and for that reason one of the safest materials for wooden houses. It does not kindle in a blaze quickly, and so absorbent is the wood that it takes in water almost immediately, so that a redwood house on fire may be saved when a pine building in the same situation could not be. It is not denied that redwood houses will burn, but it is asserted that they are less liable to burn than buildings of most other woods.

As in house construction, so in interior finish, redwood meets almost every use and requirement. Floors and ceilings are made of it, and wainscoting, panels, moldings, chair boards, brackets, shelves, railing, stair work, spindles, balustrades, and mantels.

A small quantity of redwood furniture has been on the market since the wood first came into use, but

[1] Twenty years or more ago it was not unusual in central California, near the lines of the Southern Pacific Railroad, to find numerous fields and corrals inclosed by fences with redwood posts which had served as railroad ties until too badly worn for that purpose. When the railroad removed them from the track the vineyardists and stockmen hauled them away, and splitting them made two posts from a tie and got many years of service from them.

in recent years the demand has greatly increased. Two distinct patterns of this furniture are made—that which is without figure in the wood, but with pieces and panels broad, ample, and in appearance homogeneous, and that made of figured wood.

Redwood shakes have been a merchantable commodity for 60 years in California, and have sometimes been shipped elsewhere. They are usually split from straight, perfect wood and are used for covering buildings and as siding for barns and sheds. In size they are smaller, but in use very similar to the clapboards formerly employed in the Eastern States as roofing for log cabins and other buildings. The split shake is a wasteful product, and its diminishing use is not a matter for regret. In recent years, however, there has been a tendency to saw shakes instead of splitting them. Sawed shakes were not unknown 20 years ago, but they were not much used. Some of the shingle mills have added shake saws and find them profitable. The product can be made from any wood that will make shingles and no account is taken of cross grain. The waste compared with that resulting when shakes are split is reduced to a minimum.

Redwood has been tested to some extent for paving blocks. After 15 years' service pavement of this wood has been found in fairly good condition. In this, as in many other of its uses, its resistance to decay is among its chief recommendations. It has others, however, for its softness makes it easy under horses' feet and it is nearly noiseless.

Pattern makers draw upon redwood for supplies. It has not the exclusive field even among California woods, sugar pine being a competitor, while in the East it competes with yellow poplar, basswood, and white pine. Some large manufacturers prefer redwood for this purpose, and it seems likely to gain rather than lose as a pattern material in foundries, machine shops, shipyards, and other factories and shops.

It goes to New York and other eastern cities for tobacco boxes. Comparatively few woods meet the exacting requirements insisted upon, which is that they must not impart taste or odor to the tobacco. Formerly sycamore was almost the exclusive wood for these boxes, but others have come in, notably tupelo, and now the California redwood has successfully met the requirements.

Cigar-box makers are not so choice in material as are the manufacturers of boxes for plug tobacco. Appearance has much to do with their choice, and redwood is meeting the Pacific Coast's cigar-box makers' demands.

Redwood box lumber competes with sugar pine and other coast softwoods for fruit boxes. Its dark color is sometimes objected to because it increases the difficulty of doing good stenciling. When both redwood and white fir are convenient and available, many fruit packers prefer the latter for boxes.

Musical-instrument makers do not appear to have drawn heavily upon redwood, probably because the manufacture of musical instruments is not a highly developed industry on the Pacific Coast. It is listed, however, as a piano wood by Massachusetts manufacturers.

A small quantity of this timber goes to the makers of wagons and carriages and is worked into tops, chiefly light bodies, seats, dashboards, or in panels for business vehicles, such as bread, butcher, and laundry wagons. The liability of the thin boards to split under a blow tends to limit their use, but that there is demand for them is evident from the fact that they are used in shops thousands of miles from the native timber belt.

Coffins of this wood are largely used on the Pacific Coast, where they compete with those of the native cedars.

Before slate and composition blackboards for schools had largely taken the place of all other kinds redwood held a sort of monopoly for extra widths. One piece was enough for an entire board, and splicing and joining were not necessary. It was little trouble to procure planks 4 or 5 feet wide and as long as necessary. This timber has been sawed in planks 10 feet wide.

Shop signs painted on redwood are occasionally seen in England, and the wood is also used for lining cabinets, boxes, compartments, and drawers. Its use has been reported for lead pencils and champagne corks in Germany. The pearl divers of the Society Islands make of three redwood planks boats, with outriggers, which navigate the lagoons and shoals during the diving season.

Tests of paper making from redwood indicate that the enormous waste about the mills and logging operations might be turned to account. The wood is cooked with caustic soda, and the black liquors from the digesters carry away the coloring matter from the pulp, which is then ready for paper making. The article thus made resembles, it is said, the grade known as butcher's paper rather than print stock.

The black liquor from the digesters is concentrated to the consistency of asphalt, then roasted and reduced to gas, similar to natural or coal gas. It may be used for illumination, for operating gas engines, or for fuel. One ton of redwood scrap from the mill is said to yield 500 pounds of pulp and 10,000 cubic feet of gas. This gas, if used in an engine, would probably furnish enough power to run the mill. It was estimated in 1907 that the waste from the redwood mills in the region of Humboldt Bay amounted to 500 tons weekly.

Redwood bark is used in a small way for many purposes—some useful, others merely ornamental. Novelty stores and souvenir stands along routes of travel in the redwood region, as well as in San Francisco and other Pacific Coast cities, exhibit many bark commodities for sale, including pincushions, penwipers, table mats, lamp mats, doilies, moisture-proof match safes, seat mats, bathroom mats, and silk-hat brushes. The bark is also used for fishing floats, temporary cork, life-buoy filling, cork jackets, cold-storage insulation, heat insulation, house sheathing, bicycle grips, mattress fillings, cork carpet substitute, and sound-deadening insulation. In small towns in the redwood region it is not unusual to lay sidewalks of wide pieces of redwood bark. Such walks are dry and moderately lasting.

The enormous size of redwood timber makes its lumbering wasteful. Sometimes very large trees crush

so completely when they strike the ground that little saw timber can be saved. The weights of the very large trees run from 500 to 1,000. Much experience and skill are needed in cutting them down. A mistake of a few yards in the direction in which they are thrown may entail an unnecessary loss of $100 or more. The debris that strews the ground when one of the 300-foot giants falls is "shoulder deep." However, more careful methods prevail than formerly. It is customary to clear a space and prepare a bed for the tree to fall in, and experienced choppers usually are able to lay the trunk where they want it. It is still the custom of loggers to peel the logs and then burn away the bark and other debris to facilitate getting them out. Often the logs are badly burned. The loss from this proceeding is very large, as much of the standing timber within reach of the fire is killed and the humus destroyed.

Many other wastes were once common, and some of them still are, but the tendency is toward better methods. Crooked and defective logs were abandoned, though they might contain thousands of feet of good lumber. Enough small timber was frequently cut for skid roads and in clearing away to stock a sawmill. In floating down rivers to the mills many logs sank and were lost, and others went to the sea.

Other items, enormous in the aggregate, figure in redwood waste and loss. Large logs are often split with powder to make them convenient to handle. This damages some the best wood. A large percentage of the trees are wind-shaken, and pin rot affects many. The defective wood and often good wood near it have been thrown away. Increasing demand, however, has caused more attention to be shown to the waste heap, and what will make lath, shingles, shakes, and ties is manufactured into those commodities and others of like kind.

PRODUCTION OF PIG IRON BY ELECTRICITY.

The first report of the experiments in the reduction of iron ore in electric blast furnaces at Trollhatten, in the Gothenburg consular district, has now been made public.

The total cost of the plant was 320,470 crowns ($85,886), which was $26,800 more than the original estimates. On the basis of the selling price for the product, which was established by the committee in charge as a basis for computing the practicability of the results, the experimental business has, however, been self supporting, even for the short period that it has been in operation.

Special attention has been given to the constructive details of the furnace, the consumption of electrodes, and best form of these to use, the consumption of electrical energy per ton of iron produced, the consumption of coal for the same, and the important problem of gas circulation and possible utilization to best advantage. In charge of these experiments have been a chief engineer, with operating engineers under him in charge of actual operation, collection of data, chemical laboratory, and drawings and calculations—in all, twenty-eight men.

SPECIFICATIONS FOR PURCHASE OF FUEL OIL BY BUREAU OF MINES.

In determining the award of a contract, consideration will be given to the quality of the fuel offered by the bidders, as well as the price, and should it appear to be to the best interest of the Government to award a contract at a higher price than that named in the lowest bid of bids received, the contract will be so awarded.

Fuel oil should be either a natural homogeneous oil or a homogeneous residue from a natural oil; if the latter, all constituents having a low flash point should have been removed by distillation; it should not be composed of a light oil and a heavy residue mixed in such proportions as to give the density desired.

It should not have been distilled at a temperature high enough to burn it, nor at a temperature so high that flecks of carbonaceous matter began to separate.

It should not flash below 60 degrees C. (140 degrees F.) in a closed Abel-Pensky or Pensky-Martens tester.

Its specific gravity should range from 0.85 to 0.96 at 15 degrees C. (59 degrees F.); the oil should be rejected if its specific gravity is above 0.97 at that temperature.

It should be mobile, free from solid or semi-solid bodies, and should flow readily, at ordinary atmospheric temperatures and under a head of 1 foot of oil, through a 4-inch pipe 10 feet in length.

It should not congeal nor become too sluggish to flow at 0 degrees C. (32 degrees F.).

It should have a calorific value of not less than 10,000 calories per gram (18,000 British thermal units per pound); 10,250 calories to be the standard. A bonus is to be paid or a penalty deducted according to the method stated under Section 21, as the fuel oil delivered is above or below this standard.

It should be rejected if it contains more than 2 per cent water.

It should be rejected if it contains more than one per cent sulphur.

It should not contain more than a trace of sand, clay, or dirt.

Each bidder must submit an accurate statement regarding the fuel oil he proposes to furnish. This statement should show: The commercial name of the oil; the name or designation of the field from which the oil is obtained; whether the oil is a crude oil, a refinery residue, or a distillate; the name and location of the refinery, if the oil has been refined at all.

The fuel oil is to be delivered f.o.b. cars or vessel, according to the manner of shipment, at such places, at such times, and in such quantities as may be required, during the fiscal year ending ....

Should the contractor, for any reason, fail to comply with a written order to make delivery, the Government is to be at liberty to buy oil in the open market and charge against the contractor any excess of price, above the contract price, of the fuel oil so purchased.

Copies of this technical paper may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

MUNICIPAL PURCHASE OF SEATTLE, RENTON & SOUTHERN RAILWAY CO.

On July 11, 1911, the following communication was addressed to Wm. R. Crawford, president and general manager of the Seattle, Renton & Southern Railway Company by the city engineer and the superintendent of public utilities of Seattle:

Dear Sir:—Ordinance No. 26069 of the City of Seattle, entitled:

"An ordinance declaring the advisability of a city electric railway on Rainier avenue and other streets, avenues and ways, and providing for the same, specifying and adopting the system or plan proposed, declaring the estimated cost thereof, as near as may be, and providing for the submission of such system or plan and the incurring of an indebtedness therefor to the qualified voters of the city for their adoption and assent thereto, or for their rejection thereof, at a special election to be held on the day of the general city election on the seventh day of March, 1911."

became effective February 9, 1911, and in conformity with Section 5 thereof, an election was held on Tuesday, March 7, 1911, and the qualified voters of the city on that date authorized the incurring of a general indebtedness of the City of Seattle in the sum of $800,000 for the purchase of the electric street railway system owned and operated by your company within the limits of the City of Seattle.

Under Section two (2) of this ordinance an appraisal of your street railway property by the Board of Public Works, was directed for the purpose of ascertaining its value and the Board of Public Works was further directed to certify such appraisal to your company for its consideration and acceptance.

Acting under the authority of this section the appraisal specified was made and the Board of Public Works approved same on June 30, 1911, and forwarded it to the City Council of the City of Seattle, which on July 3, 1911, adopted Resolution No. 3264, vesting authority in the Board of Public Works to certify such appraisal to your company.

The Board of Public Works at its regular session Friday, July 7, 1911, acting under the authority of this council resolution, authorized and directed the undersigned city engineer and superintendent of public utilities to certify the appraisal to your company and we hereby certify that we find the value of your holdings and your electric railway system within the limits of the City of Seattle, to be as follows:

Track	$198,286.45
Machinery and buildings	41,879.75
Rolling Stock	130,887.49
Real estate	15,000.00
	$386,053.69

and submit for your consideration and acceptance this appraisal to you in the name of the City or Seattle as a fair and just valuation of all the street railway tracks, poles, wires, feeder systems, barns, shops, substations, appurtenances and rolling stock as shown by inventory and appraisal herein before mentioned belonging to your company, which lie within the limits of the City of Seattle.

Under the terms of said Ordinance No. 26069, you are allowed sixty (60) days to accept the above offer and failure to accept same within said time will be considered as a rejection thereof.

Should you consider this offer favorably, arrangements for running rights, specified in Section two (2), will be made for the portions of your electric street railway system unacquired.

Transmitted herewith is a copy of inventory and appraisal of those portions of your railway within the limits of the City of Seattle made by the Board of Public Works.

Very truly yours,

(Signed) R. H. THOMSON,
City Engineer.

(Signed) A. L. VALENTINE,
Supt. of Public Utilities.

Seattle, July 12, 1911.

A copy of the above letter and inventory received on this 12th day of July, 1911, at 12 o'clock noon.

(Signed) W. R. CRAWFORD,
President Seattle, Renton & Southern Railway Co.

Under the terms of the offer the company is allowed sixty days in which to accept or refuse, and if refused the city is authorized to acquire it by condemnation.

A. L. Valentine, superintendent of the department of public utilities of Seattle, states that while the total track appraisal is only $198,286 for approximately ten miles of line, that a single section of 5177 feet of double track paved construction, put in recently, was appraised at $81,164, the material being estimated at $65,898 and the labor at $15,266. The figure on machinery and buildings may seem low, but is explained by the fact that the company buys its power from a local electric light and power company.

The outcome will be watched with much interest by the entire transportation fraternity on the Pacific Coast.

FUEL-OIL AND PETROLEUM INDUSTRY IN CANADA.

BY FELIX S. JOHNSON.

The petroleum wells of Ontario last year yielded 14,723,105 gallons of oil, valued at $559,478. This is a decrease of 3,756,442 gallons as compared with the production of 1908.

There was a diminution in the output of every one of the fields, but the rate of decline in the newer districts of Tilbury and Romney was greater than in the older districts of Petrolea and Oil Springs. Already the production has sunk to less than one-half of what it was fifteen years ago, and if the falling is maintained the supply of domestic petroleum will become relatively insignificant, unless new reservoirs are opened up. Even now more crude oil is imported than is produced in Ontario. The fields of Lambton county have been in operation a long time, and are unique because of the small individual production of the wells, which is only a few gallons a day, and of the economy with which they are operated. Being shallow, many wells may be worked by one engine on the "jerker" system, and so give a profit which if not large is constant.

The refineries, of which there are two in Ontario, distilled a total of 35,530,918 gallons of crude oil last year. Of this, 16,015,527 gallons was domestic and 19,515,391 gallons imported.

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POWER AND GAS

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Public Lands Necessary Amendments

Elsewhere in these columns will be found an abstract from the scholarly dissertation by the Director of the United States Geological Survey on necessary amendments to laws governing the acquiring of title to lands and power sites on the public domain.

The paper touches upon practically all the problems in the acquiring of title to public lands and is of vital interest to Western men. The suggestions of amendments to control oil and gas entries on the public domain are of great importance and should have the thoughtful consideration of all.

The paper does not, however, touch upon the present state of affairs in Alaska. Poor old Alaska—rent both at home and in congressional halls with dissensions and thus one of the most promising fields for national development and progress is in serious jeopardy of being crushed out by dire neglect and improper nurture. If improper means were attempted in her internal development, let us get the right method and get it quickly. If a boatman capsizes through an error in steering his canoe and is pulled out unconscious, give him a new start, resuscitate him, cure him. Don't treat him as we treat the pig, kill him first and cure him afterwards.

Technical Editors' Community of Spirit

For those engaged in a common calling it seems to be an unmistakable trait of the human race to feel the hidden intangible impulses and yearnings of comradeship, one for the other. We have all felt its charms. In his treatise on the expansion of England, J. R. Seeley has said that "there are in general three ties by which States are held together, community of race, community of religion, community of interest." On all sides we can see this subtle influence asserting itself in even much smaller units than the body politic of a State. The college student, for instance, feels it in his innermost and attempts to relieve his inexpressible pent-up feelings by yells unintelligible.

To those engaged in journalism and more particularly in its technical branch, the community of spirit is felt more strongly than in any other calling. Each week the mails are read with the deepest pleasure and silently but unfailingly we greet our editorial acquaintances of the past week. Like the good shepherd who performs the apparently impossible task of calling by name each ward within his care, we learn to designate the character and ideals of the individuals who pen the editorials. The mute lines speak traits of minute feeling which years of personal acquaintance could not fathom. The very choice of words identifies its writer as surely as the imprinted thumb marks will identify the individual. We learn to like, yes even to love, our friends with whom week by week we thus commune. Each week we renew our acquaintance

with our New York friends, The Electrical World, The Electric Railway Journal; our Chicago friends, The Electrical Review and the Electric Traction Weekly, and a number of others distributed far and wide in our country and abroad.

The whole Pacific Slope yearns to express to the world in 1915 the true spirit of the West. Our great exhibit and the hustle and bustle of a western metropolis will do much in the outward demonstration of this spirit, but after all it is the individual tapping at the hearts of men that express the enterprise and spirit of the West most fully. To you, our brothers of the technical press, the Journal this early extends its invitation to visit us and plan with us to enjoy a breath of our invigorating Western life. We have a place reserved for each and every one of you, a place high in our estimation and hidden in the recesses of the human heart.

To our New England friend who inwardly thinks technical learning was never taught correctly beyond the Hudson river; we will take you into the heart of the Sierras and high Rockies and show you the triumphs of engineering that have been accomplished by Western engineers and western graduates. To our middle westerner, who has put Niagara Falls so high in his estimation of God's creations; we will endeavor to show you that perhaps you cannot call it undignified if some of our hydraulic performances should be mentioned by a foot-note at least to a page for Niagara. To our friend who writes the staid, dignified editorials; we will lengthen your life by giving you an insight into a little bit of breezy Sanguinettie's on Saturday night. To our young editor friend just from the gay summer's outing at Coney Island and flashy eastern beaches; we will tame you down by taking you to Santa Monica, where recent laws almost require the wearing of overcoats and other costumes grave. And last, but by no means least, we want you one and all to come. We want your ideas, we want your personal acquaintance.

But of one thing, beware, the spirit of the West is magnetic, you may never go home again!!

Electric Power Anaconda Mining Company

No one has ever visited Butte, Montana, and left the metropolis of the great Treasure State with a blank or negative impression of the city. This greatest mining camp in the world is above all spectacular and unique. With its high buildings intermixed with a background of derricks and mine hoists, it presents to the visitor a weird but impressive sight, and finally suggests a possibility that there is before his vision a combination of modern city and ancient cliff dwellers' residences. But Butte is not in its appearance alone unique. Like the big State within which it is situated, the ideas put forth and believed in at Butte are big. Its mines yielding their millions naturally allow combinations and concentrations that could not be attempted elsewhere.

Situated about 130 miles to the northeast of Butte is a source of water power second to only one other in the United States. The Falls of the Missouri River at Great Falls, Montana, represent fabulous possibilities for future development of electric power. This power is now being developed on a gigantic scale which is largely controlled by interests affiliated with the Anaconda Mining Company and it is estimated that the power can be delivered in the city of Butte at a profit of $25 per h.p. per year.

Although the Anaconda Company has its own coal mines in Montana and Wyoming, thus furnishing its own fuel for steam, it is said that the cost for generating steam per h.p. per year is often in the neighborhood of $80 and where heat is used from the smelting of ores at Anaconda the cost has never gone below $60. The early possibilities of this great saving is a matter of much interest.

The operating of a mine hoist by compressed air which has been generated by an electric motor as primer mover is not new. It has been in existence in California and other States for years. The sudden call upon the receiver and the uneven operation incident thereto has necessitated in the past the installation of far heavier and more powerful motors than were necessary to meet average conditions.

In Butte the new electrical installations are unique in two particulars. First, the size and design of the electrical equipment and, second, the equalizing scheme used to save the power line furnishing the electricity for the compression of air from peaks, due to rapidly varying and intermitten loads imposed by the hoisting engines themselves. The adaptation of this method of applying power to a large number of hoists, all to be operated from a central power plant, is the first of its kind ever attempted. The total capacity of 25 of the largest steam-driven hoists in Butte amounts to 40,000 horsepower. The service required of these hoists is so intermittent, however, that the percentage of time they operate at full speed is so small that the average power required to operate all the hoists does not exceed 4000 h.p. Two months' operation of a portion of the installation has proved highly successful.

Upon the top of this innovation comes the announcement that the company's railroad, known as the Butte, Anaconda & Pacific Railway is to be electrified at an early date. The road has 50 miles of track, 27 of main line and the remainder of side tracks through the various mines at Butte and smelter at Anaconda. It is also prepared to introduce eventually an electric haulage system underground.

It is claimed that when the substitution of electric and air power for steam is completed in all the properties of the Anaconda company, it will mean a saving to stockholders of at least one per cent per pound in the production of copper, as compared with the present steam operating costs.

The signs of the times are slowly but inevitably tending toward the replacement of steam by electrical energy. The next great movement; namely, the electrification of the mountain passes and tunnels on the great transcontinental service, is each day brought one step nearer.

PERSONALS.

G. C. Noble, consulting engineer, has been at Bakersfield during the past several days on business.

W. H. P. Hill, a light and power official of Monterey, recently spent a few days at San Francisco.

Robert B. Moran, consulting engineer, has been a busy visitor in Southern California during the past two weeks.

E. F. Flinn, of the Allis-Chalmers Company's sales corps, with headquarters at San Francisco, is making an Eastern trip.

J. D. Farwell, who is connected with the lighting system at Los Gatos, was a San Francisco visitor during the past week.

Jos. N. Le Conte, hydraulic expert, is home again in Berkeley after a very pleasant month's outing in the high Sierras.

J. S. Thompson, manager of the Pacific Electric & Mfg. Co., has returned to San Francisco from a successful trip through Southern California.

H. C. Camp, electrical engineer, is a recent arrival at San Francisco. He is touring the Pacific Coast and inspecting high-tension power transmission systems.

Geo. Cole of the John R. Cole Co. is again at the San Francisco headquarters of the house. Benjamin Chase has recently been made Los Angeles representative.

H. W. Crozier, of Sanderson & Porter's Pacific Coast branch office, has been visiting Victoria, B. C., where the firm have supervision of two large engineering jobs.

H. F. Dodge, division commercial superintendent, and H. C Chace, division traffic superintendent, returned to San Francisco at the same time after visiting Los Angeles.

Hugh McPhee, district commercial superintendent of the third district of the Western Union Telegraph Company, with headquarters at Los Angeles, arrived at San Francisco last Monday.

F. H. Varney, engineer of operation and maintenance in the steam section of the San Francisco Gas & Electric Company, has returned to San Francisco after a tour of Southern California.

C. A. Rhodes, who was recently appointed division auditor of the Western Union Telegraph Company's Pacific Division, comprising eleven states, has opened his office at Room 239, Russ Building, San Francisco.

K. E. Van Kuren, a special switchboard engineer of the Westinghouse Electric & Manufacturing Company of East Pittsburg, has just returned to the East after spending some time on a tour of the Pacific Coast.

H. G. Glass, one of the engineers of the Westinghouse Electric & Manufacturing Company, with headquarters at East Pittsburg, spent the past week at San Francisco visiting W. W. Briggs, the company's Pacific Coast general manager.

Loren Hunt, one of the engineers under City Engineer Marsden Manson, has been promoted to the position of chief assistant engineer in place of H. D. H. Connick, who resigned to take a position with the Panama-Pacific Exposition project.

J. C. Farrar, specialist in bus-bar and high-tension switching construction was in San Francisco from Los Angeles this week on his way to Portland and Seattle. He reports that construction at the new Long Beach plant of the Southern California Edison Co. is progressing rapidly.

F. V. T. Lee, a capitalist of London, who was at one time assistant to the general manager of the Pacific Gas & Electric Company, visited San Francisco during the past week on his way to Bohemian Grove where he will witness the "high jinks" of the Bohemian Club before returning to England.

C. L. Cory, the well known consulting engineer of Berkeley and San Francisco, has returned from an extensive trip through the northwest. Professor Cory has been absent for the past five weeks during a large portion of which time he has been engaged in valuation work for the Washington Water Power Co. at Spokane.

ELECTRICAL CONTRACTORS' ASSOCIATION NEWS.

E. C. Wakeland, a well known contractor of Oakland, has opened a place in San Francisco.

E. F. Burkhart, secretary of District No. 10, California State Association of Electrical Contractors, of Palo Alto, was at San Francisco last Tuesday on business.

Bids for a lighting system at Fort Miley were received August 3d from the following firms:

Newberry-Bendheim Co.	$16,500
John J. Sutton Co.	17,000
McFell Electric Co.	17,200
Standard Electric Co.	18,250
Butte Engineering & Electric Co.	20,477
Central Electric Co.	21,603
Decker Electric Co.	22,530

Secretary W. S. Hanbridge says:

It is with a great deal of pleasure that the reports from the National Convention of Electrical Contractors are received. If the coming year is as successful as the past there will be very few contractors who are not enrolled under the National banner. A number of very fine papers were read and it all means more light to the contractors, and we join with President Barnes in hoping that this convention will set a new mark with respect to establishing a closer community of interest between the several elements, which should work together in order that there might be a maximum of prosperity for all.

The next convention will be held in Denver, and from the looks of that baseball score (9 to 6), we will have to buy a few pitchers if we want to win the game in 1915. But don't get discouraged, fellows, as they only played three innings.

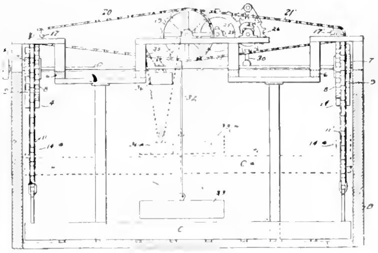
If they could only have seen Fleishman when the score was tied in the ninth at Catalina!

A great deal is being said about co-operation of the contractor and the central stations. A recent trial has been brought to our notice where the central station manager called the contractors together and told them he wanted to start a heating appliance campaign and he had instructions to put out solicitors and advertise in papers. He made them the proposition that he would carry the stock and allow them the commission, if they would carry out the campaign. His proposition was accepted. He ran an ad telling people that appliances could be had for a certain price at the stores. The result was every contractor in town was working for him, and it is needless to say that the campaign was a success. Every contractor in town has a good word to say for such broad-minded methods.

An examination will be conducted on August 23-24 and 25 by the U. S. Civil Service Commission for the appointment of an electrical engineer and draftsman, salary $1200 per annum.

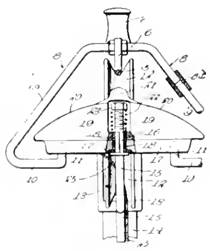
PATENTS

999,198. Tidal-Power Device. Thomas G. Bird, Eugene, Ore., assignor of two-fifths to Marcellus P. Bonnett, Eugene, Ore. A tidal-power device comprising a compartment, a float of suitable weight movable vertically therein suspended from sprocket wheels rotatably mounted on a main shaft, a rotatable main shaft having near its ends ratchet pinions rigidly secured



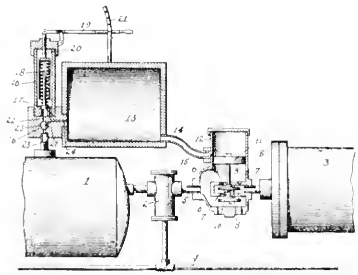
thereon and sprocket wheels rotatable on the shaft, provided with pawls on one face in position to engage the pinion ratchets when the float descends, link chains having one end secured to the float and passing over the sprocket wheels, also means to cause said chains to rotate the pawl sprockets reversely when the float ascends substantially as described.

999,312. Trolley-Switch for Station-Indicators and the Like. Orlando E. Kellum, Los Angeles, Cal., assignor to National Street and Station Indicator Company, Los Angeles, Cal., a corporation of California. In combination with a trolley wire and a member engaging therewith for longitudinal movement



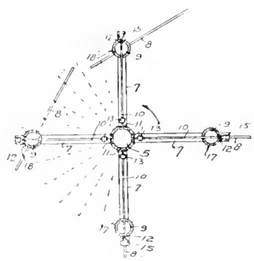
thereon, and a support for said member, a contact member suspended from the wire and having an upwardly facing contact surface thereon, and a contact member mounted on said support and adapted to pass over and engage with the contact surface on the first-mentioned contact member.

999,351. Air-Brake Apparatus. John H. Wallace, San Francisco, Cal. In air-brake apparatus and in combination with the auxiliary reservoir, brake-cylinder and triple-valve; a regulating reservoir of the same capacity as the brake-cylinder, connected primarily with the auxiliary reservoir and provided with means for arbitrarily defining the primary pressure received therefrom, said regulating reservoir being also secondarily connected with said auxiliary reservoir through the triple-valve; and means controlled by a difference of pressure in said secondary connection for keeping open the communication between the triple-valve and the brake-cylinder, until the pressure in the latter exceeds that primarily given to the



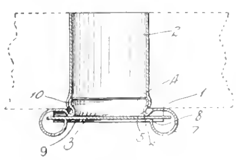
regulating reservoir, and thereupon closing said communication and admitting the excess of pressure into the regulating reservoir through said secondary connection.

999,423. Windmill. Earl Woodrum, Glencove, Wash. In a windmill, the combination of a fixed post; a set of arms rotatably mounted thereon; wings pivoted to said arms; a fixed gear mounted on said post; gears secured to said wings;



means connecting the fixed gear to the wing gears whereby said wing gears are operated by the rotation of the mill; means for releasing said connecting means; and means mounted on said wings and controlling said releasing means.

999,457. Flume-Gate. George E. Kellar, Los Angeles, Cal., assignor to Kellar-Thomason Manufacturing Company, Los Angeles, Cal., a corporation of California. A flume gate compris-



ing an apertured plate having a flange projecting to one side from the edges of the apertures in said plate and a tubular portion having its edge fitting upon said flange, and crimped tightly thereon for joining the parts.

INDUSTRIAL

ALTERNATING CURRENT TRANSMISSION LINE CALCULATOR.

While the determination of the voltage and energy loss in alternating current transmission lines and distributing circuits does not present any especial difficulty to the designer who has frequent use for the necessary tables and formulas, there are many operating engineers and superintendents who are responsible for results and recognize the value of accurate methods but whose knowledge of the technical details involved has been crowded out of mind by broader executive problems. It is in view primarily of the needs of the latter class that there has been devised and is now being placed on the market a simple and reliable device for calculating the line drop and energy loss in alternating current circuits. This device is called the "Alternating Current Transmission Line Calculator," and is made by Robert W. Adams, and is for sale at the Technical Book Shop, 604 Mission street, San Francisco, for one dollar each.

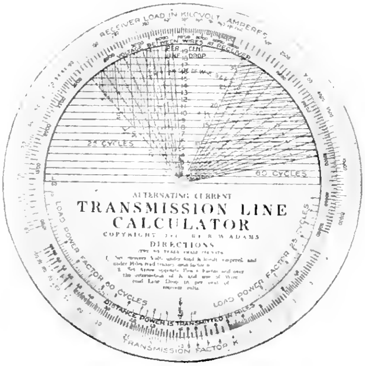


Fig. 1. Transmission-Line Calculator.

The calculator consists of two disks, a stationary one of opaque white celluloid 4¼ in. in diameter and a revolving one of transparent celluloid 3 9-16 in. in diameter, eyeleted to the stationary disk so as to turn easily upon it. These disks are printed with the necessary diagrams, the stationary diagram being in red and the revolving diagram in black to permit of easy reading. The printing is done by a patented process which renders the lines moisture proof and non-erasible. The ranges of the various scales are as follows: Load, from 10 kw. to 20,000 kw.; voltage, from 1000 volts to 50,000 volts; power-factor, from 10 per cent to 100 per cent; distance, from 1 mile to 100 miles; conductor, from No. 8 to No. 4-0; line drop, from 0 per cent to 20 per cent; frequency, 25 cycles and 60 cycles.

In operation it is only necessary to make two settings to obtain the result. The value of "K," which is obtained in the first setting, is a transmission factor depending on the load, voltage and distance of transmission, and this factor is used directly in the second setting to determine the line drop, or "regulation," which is defined as the difference in voltage between the two ends of the line expressed in per cent of the receiver voltage. The method of securing the result includes in an accurate manner the effect of load power factor, which has become increasingly important with the recent remarkable development of motor load, and, furthermore, is easily reversible, a feature which is not possessed by the algebraic methods and one which is of great value where it is desired to obtain the size of wire necessary to produce a given drop.

Complete directions are printed on the back of the calculator, together with a typical example, by following which a person having no technical training whatever may readily learn the method.

Upon the back of the stationary disk is also printed a convenient reference table giving the weights and costs of bare and triple-braid weatherproof copper wire per mile of two-wire, three-wire and four-wire circuit. This table is new and will prove useful for estimating the cost of proposed lines. Another useful feature is that the two lower revolving scales ordinarily representing distance and transmission factor can also be used as an emergency slide rule for solving problems in multiplication and division. The time required for a person acquainted with the calculator to make a complete determination of line drop is stated to be less than one minute.

The calculator is based on the use of annealed copper wire at 20 deg. C. (68 deg. Fahr.) or hard-drawn copper wire at 15 deg. C. (59 deg. Fahr.), and on three-wire, three-phase, and four-wire, two-phase circuits. Single-phase circuits can be calculated as easily as three-phase, although the device is primarily designed for three-phase circuits as being the most common for transmission work. The diagrams are based on a spacing of 18 in. between wires and are sufficiently correct for all practical work on circuits varying from 6 in. to 48 in. spacing. It is stated that the accuracy of the calculator will compare favorably with similar results obtained by any of the formula or graphic methods, and in all cases will come far within that of the original assumptions of load and power-factor.

IMPORTANT LIGHTING CONSIDERATIONS.

BY F. B. ALLEN.

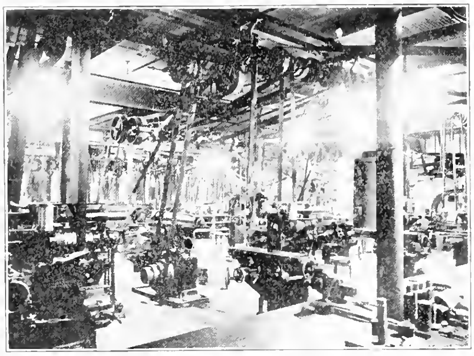
An employee's efficiency depends upon two things, ability and willingness to do the work. As far as ability is concerned, it is dependent upon three considerations: first, powers of perception, of which in nearly every case sight is of the greatest importance; secondly, brain, or intellect, to direct, and lastly, body to perform the work. Willingness to labor depends upon conscious and subconscious will. Consciously, wages are largely influential in producing the will to work; subconsciously, the realization of fair treatment by employers, and conditions in the factory tending toward health, such as correct illumination, temperature, ventilation and sanitation.

There are four qualities in illumination which should be considered: first, the correct amount of light, that is, the happy medium between dimness and dazzling brilliancy; second, the lack of glare of high intrinsic brilliancy; third, the lack of flickering, and lastly, the elimination of harmful radiations.

Under the correct amount of light we may say that the eye is able to work under a broad range of intensities. Thus, we can often read accurately in moonlight and still can do so in dazzling sunlight, the latter being over a million times the brilliancy of the former. It may be stated, however, that dependent upon the class of work, the eye should be exercised under from ½ foot candle to 15 foot candles. Glare is an extremely harmful characteristic in any illumination. It not only cuts down the ability of the eye to see accurately, but produces eyestrain and nervousness. Flickering is also an extremely deleterious quality. Its results are about the

same as are produced by glare: inefficiency of the eye in working, together with eyestrain, due to the rapidity with which the eye tries to re-focus under the different intensities. This quality may be brought about in either one of two ways. Either the light source varies in intensity or the light upon a given plane of working is not even. In either case the eye must re-focus very often.

The most effective rays in producing vision are the yellow and green. The fact that these are the principal rays in the spectrum of the Cooper Hewitt lamp accounts largely for the reason why many consider it to have very high illuminating efficiency. The rays on either side of these in the natural spectrum are of less practical value, since they require to be much more powerful in order to produce the sense of vision, and hence strain and fatigue the eye to a correspondingly greater extent. The red and heat rays are particularly irritating for this reason. The different colors also produce well known mental effects. Thus, red is exciting, while blue and violet are depressing. The use of a red flag in bull fights and the well known expression "feeling blue" are recognitions of this fact. Yellow gives contentment, while green is restful.



Shop Lighted by Cooper-Hewitt Mercury Arc Lamps.

Many consider that the mercury vapor lamp has qualifications which are extremely advantageous to industrial illumination. It is a scientific fact that the eye will focus more accurately under the green rays produced by this lamp than under a combination of the seven colors of the spectrum. For this reason it is extremely advantageous to employ the light where accurate eye work is required. It is evident for the same reason that the eye can see more distinctly under lower intensity of illumination with green light than with a combination of the seven colors of the spectrum. The application of this to industrial illumination results in the ability to entirely eliminate auxiliary lights of small candle power where ordinarily the illumination from an overhead system would not be sufficient.

The light produced by the mercury vapor lamp is extremely low in intrinsic brilliancy, the amount of light being produced rather from the area than from the brilliancy of the source. This results in a total absence of glare, not only where the source is directly exposed to the eye, but from polished surfaces. This reflection of glare from polished surfaces is found to be extremely annoying and of as serious a character as the exposing of the direct rays of the lamp.

Where Cooper Hewitt lamps are employed, the system is of an overhead character. The lamps are placed to light a certain number of square feet and are laid out symmetrically, regardless of the placing of the work beneath. This produces a perfectly evenly distributed light on the floor. It may be seen, therefore, that upon a working surface no different intensities of illumination will be found, and, therefore, the eye will not be called upon to re-focus. The source, which is the tube varying in length with the different types of lamps, is a steady line of light, being in any given period of exactly the same intensity. The length of the source is a very decided advantage, tending towards distribution and the elimination of distinct shadows.

An analysis of the qualities of the mercury vapor lamp will show that where color values are of little importance, the other qualities of the light are exactly those which are required to produce correct illumination for employees in industrial work. The importance of this cannot and must not be overlooked. For instance, in one of the large silk mills of the east, it is figured by a well known cost expert that the expense of producing their product at night is 20 per cent higher than that of producing it in the daytime. This may have been due to several things, but must be largely attributed to inferior illumination. Had those people in their factory had an illumination during the dark hours which was as good for working purposes as the best daylight, their cost of production during that time would very evidently have been largely decreased. It seems strange that the importance of this consideration has been overlooked, particularly in view of the fact of the extremely low comparative cost of units of illumination and of their operation.

A large modern factory, it may be figured, can produce power at a cost of one per cent per kilowatt hour. A mercury vapor lamp can be run five hours at a power expenditure of one kilowatt hour. On an average in industrial lighting one mercury vapor lamp will take care of at least two men. Figure an average cost of 40 cents per hour to employ these two men. This would mean an expense of \$2.00 to employ these two men five hours, whereas perfect light for them can be produced for one cent. In other words, if perfect light will save one-half of one per cent of a man's time, it has paid for its total cost of operation.

Not only that, but the value of machinery and factory investment is increased in proportion as the efficiency of the men is increased. Thus, with improved illumination it is not difficult to imagine that 20 machines will do the work that 25 had done heretofore. The value of the given investment has increased 20 per cent, or probably ten times the value of the lighting units to produce this result.

These are the important considerations in any lighting installation, and cannot be overlooked. Any system of figuring which does not consider these points is entirely fallacious and can mean but little.

As far as actual operating cost goes, however, it may be said that many consider the mercury arc lamp to be one of the most efficient units at present on the illumination market. Further, its cost of up-keep is extremely low, both as to attention and repair parts required to operate, and as to the actual renewal expense of the tubes. It may be conservatively said that ½c per kilowatt hour will cover all maintenance and expense of operation.

TRADE NOTES.

The Great Northern Railway, which already has nearly 4,000 miles of track equipped with telephone train dispatching equipment, has just placed an order with the Western Electric Company for thirty-two telephone selectors to equip its Cascade Division.

The Arctic Mining and Power Company have closed contracts for an electric generating plant to supply power for use at their mine in Nevada County, Cal., and also for transmission about ten miles to surrounding mines. The Fort Wayne Electric Works will furnish a complete 5-panel switchboard for the distribution of the current from a 600-kw., 6000-volt generator ordered from the Ridgway Dynamo and Engine Company of Ridgway, Pa.

NEWS NOTES

FINANCIAL.

AUBURN, WASH.—The Council is to call a special election soon for the purpose of bonding the town for $15,000 for municipal purposes.

ELLENSBURG, WASH.—Voters of this city are to be asked to approve a bond issue of $100,000 to improve the municipal light plant.

SACRAMENTO, CAL.—That $100,000 will be spent in the next year in extending the East Sacramento Water System is the statement made by H. McClelland, president of the East Sacramento Water Co.

EUGENE, ORE.—Bids will be received by city recorder, R. S. Bryson, up to Aug. 24th for the purchase of $57,000 light, power and water bonds.

SEATTLE, WASH.—J. D. Ross, superintendent of lighting, will call for bids at once for the painting of about 20,000 light poles throughout the city.

PENTICTON, B. C.—Bids were received up to August 10th for furnishing of electrical equipment, power station, pressure pipe and plant complete.

SEATTLE, WASH.—The Seattle-Tacoma Power Co., 7th and Jefferson Streets, will erect a $1,000, 1 story, fireproof, steel and reinforced sub-station, 1763 Railroad Avenue, near East Waterway. Owners, architects and builders.

MONMOUTH, ORE.—The City Council has taken up a bill preparatory to the issuance of bonds for the construction of a water system. The bill provides for the issuance of $25,000, but for the sale of only such part as may be necessary to complete the system.

PORTLAND, ORE.—The Mt. Hood Ry., L. & P. Co., Lewis bldg., have taken out a permit for the construction of a 2 story reinforced concrete sub-station, to be erected at the foot of Williams Avenue. The building to cost $60,000. The owners are the builders.

SPOKANE, WASH.—The Spokane Falls Gas Co. is to expend $18,000 on the extension of its mains to the north hill district. Contracts amounting to $15,000 have been let to the Improvement Equipment Company of New York for reconstruction of the coal gas generator capacity.

EXETER, CAL.—Not desiring to place any larger debt than is necessary on the city of their adoption the trustees in regular session, decided to cut down the proposed bond issue to the tune of $3,000 or to call for $42,000 instead of $45,000. A resolution was adopted determining that the public interest and necessity demand the construction of a water system in said city, and the estimated cost is $42,000.

WHITE BLUFFS, WASH.—It is probable that formal announcement will be made within two months by the Pacific Power & Light Co., of its intention of the expenditure of between $6,000,000 and $10,000,000 in the development of hydroelectric power on the Columbia river, at Priest Rapids, near this city. The improvements include the construction of a dam at the rapids, 75 ft. in height, construction of the high line ditch of the Hanford project, and the construction of a network of electric power transmission lines in this vicinity and providing power to a large section of Eastern Washington.

LOS ANGELES, CAL.—John B. Miller, president of the Southern California Edison Company, says that the industrial growth of Southern California has increased to such an extent that more electricity is now used for power than for lighting purposes. A close scrutiny of the increase in the use of power shows that it is general over the entire system. The manufacture of cement has been the largest single industry for which electric power has been used until recently, now its adaptation to pumping oil wells and for refining purposes is taking first place. And the agricultural phase of power consumption is almost as important as the manufacturing feature.

SAN FRANCISCO, CAL.—The Metropolitan Light & Power Co. has filed an agreement in the U. S. Circuit Court similar to that of the San Francisco Gas and Electric Co. in regard to rebates. Under the terms of the agreement the consumers will be paid back the sum of $38,791 for the year beginning July 1, 1909, and $49,193 for the year ending June 30, 1911. The interest, amounting to $1606, will be divided between the corporation and the city and county of San Francisco after the expenses of Court Commissioner Maling have been paid. Under the same agreement the gas rates for the next six months ending Jan. 1, 1912, will be 85c per thousand, and after that date until June 30, 1912, the rate will be 80c per thousand.

SAN FRANCISCO, CAL.—A statement of the receipts of the United Railroads for the year 1910, on which a percentage to the city must be paid, has been filed by the company with the Supervisors. It puts the amount of the city's percentage at $38,756.98. The amount paid for 1909 was $37,482. The figures for the various United Railroads lines are set down in the statement. Most of the lines pay 2 per cent of the gross receipts to the city, seven of them 3 per cent, and one, that running on 6th and Sansome streets, 4 per cent. The receipts on the lines subject to the 2-per-cent tax were $1,784,837.54, on the 3-per-cent lines $83,296.91, and on the 4-per-cent line $14,033.49. The filing of the statement was delayed, as the company wanted to ascertain whether or not the new State tax law relieved it from liability for further payment of its franchise percentages. It found that it still had to pay.

MODESTO, CAL.—The sale of the lines, equipment, franchise and good will of the La Grange Water and Power Co. in Modesto to the Sierra and San Francisco Power Co. is announced officially here. The price paid was $50,000. This transaction ends the competition between two lighting companies of the city, since the La Grange Co. came into the field over five years ago. It is understood that no other branch of the Mount Whitney Power Co, the holding company for the La Grange, has been effected. The Sierra and San Francisco Power Co., of which George W. Bacon of New York is president and in which Patrick Calhoun is heavily interested, retails power in no part of the country except in this section of the San Joaquin Valley. The big plants of the company near here send 80,000 h.-p. into Modesto, and the United Railroads in San Francisco are operated by the company. It is understood that John Hays Hammond represents the majority of the capital behind the corporation, which has just sold the La Grange Power Co.

INCORPORATIONS.

PORTLAND, ORE.—Pierce-Tomlinson Electric Co., capital $1,000, has been incorporated by T. F. Pierce.

SAN BERNARDINO, CAL.—The Pacific Electric Heating Co. of Ontario has been incorporated with a capital stock of $25,000. The incorporators are: E. H. Richardson, B. C. Shepard, C. A. Shepard and T. E. Parke, all of Ontario, Cal.

ALBUQUERQUE, N. M.—The Tucumcari Light and Power Co. has been incorporated with a capital stock of $100,000.

CHELAN, WASH.—The East Side Telephone Co. of Chelan has been incorporated for $2,500 by H. A. Steele and Chas. Colver.

CEDARHOME, CAL.—The Cedarhome Telephone Co. of Cedarhome has been incorporated for $10,000 by Peter Hanson and N. Nielson.

UNDERWOOD, CAL.—The Underwood Telephone Co. of Underwood has been incorporated for $2,000 by J. H. Hussey, M. Smith and H. Love.

SEATTLE, WASH.—The Williams Submarine Telegraph Co. of Seattle has been incorporated for $1,000,000 by A. Williams, Horace P. Chapman and G. Parsons.

ILLUMINATION.

ASHLAND, ORE.—The franchise of the Ashland Electric Light & Power Co. has been revoked. The city's municipal plant will soon be in operation.

GRANDVIEW, WASH.—This place has granted a 50-year franchise to the Pacific Power & Light Co. to furnish electricity. Service to be furnished in 60 days.

SIERRA MADRE, CAL.—The Southern Counties Gas Co. will supply Arcadia, South Santa An.ta and Elmonte with gas from the Monrovia plant as soon as the main line now being extended is completed.

MARYSVILLE, CAL.—The Northern Electric intends expending a considerable amount of money in Marysville within the next three or four months for the erection of new car barns and a passenger station on C St., also building new yards and tracks.

SAN BERNARDINO, CAL.—The Board of Supervisors has passed an ordinance granting to the Southern California Gas Co. a franchise for a period of fifty years, to maintain a system of gas pipes under and along public roads and highways of San Bernardino County for furnishing gas for heat, light and power.

WATTS, CAL.—The Pacific Light and Power Co., through its representatives, Messrs. Burns and Davis, presented a proposition to the board for electricity and furnishing the city forty-five lights at a flat rate of $150 a month. $9,000 being the cost of construction. A contract for five years was entered into.

HONOLULU, T. H.—The progressive towns of Wailuku and Kahului are to have electric light and power, for the distribution and supply of which a franchise was granted to the Hon. H. P. Baldwin, B. A. Wadsworth, J. N. S. Williams, D. C. Lindsay, C. D. Lufkin, James L. Coke and W. T. Robinson. As the result of this decision the franchise has finally been purchased by the Island Investment Co. of this city, which will erect the necessary plant midway between Kahului and Wailuku and later turn both plant and franchise over to the Maui Electric Co.

SAN BERNARDINO, CAL.—For the purpose of establishing a $75,000 central plant for furnishing gas to San Bernardino, Redlands, Riverside and Colton, the Southern California Gas Co., a subsidiary corporation of the Pacific Light and Power Co., has purchased seven acres of land near Colton. The plant is to be constructed at once, plans now being drawn up. The lighting company recently was granted a franchise covering the roads of the county, by the Board of Supervisors. Five thousand dollars was paid for the building site, which is located on Colton Avenue, just south of Colton.

SAN JOSE, CAL.—J. H. Hornung, representative of the Great Western Power Co. announces that his company will put men in the field here to offer contracts for light and power in competition with the United Gas and Electric Co., which now has a monopoly in the local field. Hornung states that prices less than those which obtain will be offered, and that a service not subject to breaks on account of accidents on ditches and flumes is guaranteed. Hornung, in telling of the concern's backers says: "The company has a capital of $25,000,000, and is one of the most powerful concerns of the kind on the Coast. It recently absorbed the City Electric Co. of San Francisco. Edward Hawley, the famous railway man, is president, while the interests on the Pacific Coast are looked after entirely by Mortimer Fleishhacker. We are arranging now to put a cable under the bay and furnish electric power, generated by hydraulic power, into San Francisco and San Jose is naturally the next point to be reached. We shall do a gas and electric business, and our solicitors will sign up contracts for furnishing light and power."

TRANSMISSION.

LEWISTON, IDAHO.—The Nez Perce Power & Light Co. is making preparations to invade this territory, according to reports.

MOSIER, ORE.—The Pacific Power & Light Co. has about started construction work on an electric supply line from The Dalles to this place.

CONCORD, CAL.—The Board of Trustees passed an ordinance granting to Great Western Power Co. a fifty-year franchise for a transmission line through this city.

ROSEVILLE, CAL.—The Northern Electric Co. proposes to extend its electric system to this city for the benefit of the fruit interests between Roseville, Orangeville and Fair Oaks.

PT. ANGELES, WASH.—P. J. Woods of this city was awarded the $18,000 contract by the Olympic Power Co. for preparing the right of way for the transmission line for the entire way from this city to Irondale.

RIVERSIDE, CAL.—The Board of Supervisors has passed an ordinance granting to Fred B. Mechling, franchise for a period of fifty years for a transmission line along all public roads and highways in Riverside County.

SALINAS, CAL.—The Monterey County Gas & Electric Co. has made application to the board of supervisors for a franchise for a period of thirty years for a transmission line along all public roads of Monterey county.

KLAMATH FALLS, ORE.—It is announced that the Siskiyou Light & Power Co. is having surveys made for the extension of the power line to Klamath Falls. The 80 h. p. turbine has been installed and will be ready for operation in about 3 weeks.

SAN BERNARDINO, CAL.—The Board of Supervisors has awarded the franchise for an electric pole line throughout the county to the California, Nevada Power Co., composed of Denver capitalists, at $150,000. Work will start at once and $10,000 will be expended within three years.

TRANSPORTATION.

PORTLAND, ORE.—Immense car barns are to be erected by the Portland Railway, Light & Power Co. between East 26th and East 28th and East Burnside and East Couch streets in this city.

BERKELEY, CAL.—The Council has passed an ordinance granting permission to the Oakland Traction Co. a franchise for a single or double track street railroad, to be operated by electricity upon certain streets in the city of Berkeley.

SANTA MONICA, CAL. The city council has passed an ordinance granting to the Los Angeles Pacific Company the right to construct and for a period of forty years to operate a single or double track electric railroad along certain streets of the city.

CORVALLIS, ORE.—The entire holdings of the Corvallis & Alsea River Ry. Co. has been sold to the Portland, Eugene & Eastern Ry. Co., including 31 miles of right of way track terminals at this place, rolling stock, etc. The purchasing company, it is reported, will electrify 18 miles of the road from this place to Monroe and then extend the line from Monroe to Eugene, a distance of 22 miles. Power for operation of the new line will be furnished by the Oregon Power Co.

OAKLAND, CAL.—That the electrification of all the old S. P. lines throughout Oakland, Alameda and Berkeley will be completed by the first of December, is the report of the engineers in charge of the work. This includes the three lines in Alameda, the second of which will be in working order within the next two weeks, the loop over Franklin and 20th Streets and the 7th Street and East Berkeley lines. Plans are being drawn for the enlargement of the old train sheds at the mole in an effort to do away with the long waits and confusion caused by the single-track system on the suburban lines. It is proposed to have two tracks for the horseshoe, East Berkeley and 7th Street trains.

OAKLAND, CAL.—An official of the Oakland-Antioch Railway announces that it had been practically decided to construct the Danville branch, but that the Martinez project was still under consideration. The present terminal of the line is at Bay Point, a point seven miles from Martinez. Two routes are being considered for the branch to this place. The first is along the shore of San Francisco Bay, direct from Bay Point. This route would take in a half-dozen important manufactories and industries situated along the bay shore. The other route being considered is to branch off at Concord, come through the Alhambra Valley, touch at Pacheco and on into Martinez. The branch to Danville is to leave the main line of the electric road at Walnut Creek.

WATERWORKS.

PUYALLUP, WASH.—At a special meeting of the city council it was decided to construct a pumping station and lay water mains at Maplewood Springs.

ASTORIA, ORE.—Construction is under way on the contracts amounting to $100,000 to include the building of new reservoir and laying of high service mains.

CENTRALIA, WASH.—The Council has granted to the Washington-Oregon Corporation the authority to maintain water mains across public streets in this city.

NOGALES, ARIZ.—The Nogales town council has decided to call a bond election to determine whether or not Nogales should issue bonds to supply funds for municipal water and sewer system.

PENDLETON, ORE.—The city water commission has purchased of Nancy E. Despain several blocks above the present reservoir to be used for the site of the reservoir for the new gravity system.

DORRIS, CAL.—Sealed bids will be received by the clerk of the Board of Trustees up to August 25th, 1911, to build the Dorris Water Works system, according to plans and specifications on file with the clerk.

CHALLIS, IDAHO.—The electors voted bonds for the construction of a system of municipal water works. The proposition was carried by a vote of six to one. Within the next few months the city will have a water system.

KLAMATH FALLS, ORE.—Announcement has been made by officials of the Klamath Falls Light and Water Company, that Shippington, that portion of Klamath Falls bordering on the Upper Klamath Lake, is soon to be supplied with city water.

ASTORIA, ORE.—The Board of Water Commissioners have decided to put in a dam at the head works for the purpose of increasing the storage capacity of the water system and the engineer has been ordered to prepare and submit plans accordingly.

TROY, IDAHO.—The Board of Trustees has offered for sale the $12,000 negotiable coupon bonds, to bear interest at 6 per cent per annum to be paid on first days of January and July in each year at the Chase National Bank, New York, N. Y., to be due in 20 years.

MARSHFIELD, ORE.—The council of this city and that of North Bend, have united with a view of securing data in regard to the construction of a municipal water system to serve both cities. The cost of construction will be obtained and a competent engineer will make surveys and investigate other water supplies.

CHELAN, WASH.—Engineers employed by O. A. Hoag have started preliminary surveys for the construction of a pipe line to take water from the Chelan river for power purposes. The water will be taken from the river near the city dam and carried to a point near Lake Chelan where the water will be utilized in a water plant.

SANTA ROSA, CAL.—The Santa Rosa Water Works has commenced work at the spring, formerly owned by the Fountain Water Co. The plans of the company have not been fully matured but it is their present intention to proceed with the work of installing a rotary pump with direct connection with an electric motor which will be used to pump water from the spring to an elevated point between it and the present reservoir of the company.

OAKLAND, CAL.—The Board of Supervisors has called for bids for the construction of a water plant on the Altamont road, the system to cost in the neighborhood of $8,300. Bids were called for a retaining wall in the San Lorenzo creek at an estimated cost of $1400 and a bridge and retaining wall near Brightside to cost $3600. The contract for the construction of a water plant on the Lake Chabot road was let to Thomas B. Russell on his bid of $2944.

TELEPHONE AND TELEGRAPH.

JOSEPH, ORE.—J. F. McClain, superintendent of the Wallowa forest reserve, has received instructions to build a line from Joseph to the Rangers camp, a distance of 15 miles.

VANCOUVER, B. C.—The British Columbia Telephone Co. has presented plans for the construction of its propcsed pole line on the north side of 11th avenue from Glen to Woodland avenues, and for underground work on the south side of Pender street.

HOLLISTER, IDAHO.—The local telephone system and exchange connecting with the Bell line to Twin Falls and other points on that system and communicating with Jarbidge over the line of the Idaho, Nevada Telephone Company will be established as soon as sufficient subscriptions have been obtained.

SAN FRANCISCO, CAL.—The architectural department of the Pacific Tel. & Tel. Co., with offices in the New Montgomery exchange building, have completed the plans for the construction of a three story and basement brick building, which will be used for the company's business in the Sunset District. The building will be located on H street near 19th avenue and when completed will cost in the neighborhood of $30,000.

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HUNTING RESERVOIR SITES IN THE HIGH ROCKIES

BY ROBERT SIBLEY.

During the past several years the progress of the great Northwest in matters of development has been next to miraculous. The conversion of barren lands into rich fruit bearing regions has taken place on all sides. Especially is this true of that portion of the Northwest situated in Western Montana. A few years ago this great commonwealth was known as the Treasure State, symbolic of its great wealth in mineral resources. Its millions of acres of arid lands in the eastern portion of the State were thought to be hardly fit for sheep herding, while the timbered lands on the Pacific Slope were thought to involve too heavy an expense in clearing to ever be of profitable value.

Fig. 1. Delightful Summer Lodge of the O. W. Kerr Company, Charlos, Montana. Typical of the many artistic retreats being constructed in the Bitter Root Valley. Large canal shown below club house.

Today the change is marvelous. Mineral production in the State is already exceeded by agricultural returns. In Eastern Montana gigantic reclamation projects are being undertaken both by the government and private enterprise under the Carey land act. These transitions are second place, however, to the beautiful and scientific development taking place in the protected valleys in the western portion of the State. Here, lands that were stripped of every available stick of timber and left to bleach their once sheltered soils in the noonday sun are beginning to reappear as modern productive orchards, fruitful and profitable.

Typical among these valleys is the fertile Bitter

Root which extends north and south about sixty miles in length and varies in width from four to twelve miles. At the head of this valley where the beautiful Bitter Root river joins the murky Missoula is located the thriving Western Montana metropolis, the city of Missoula. According to the last official census returns Missoula ranks third in cities of the State with a tributary population of about fifteen thousand people. The Bitter Root valley is of historic interest, as it was traversed from end to end by Lewis and Clark over a century ago. It was first called to the attention of the world, however, when the late Marcus Dailey located his gigantic stock farm in the very heart of this productive valley. This farm had within its holdings some twenty-seven thousand acres and after a few years' operation it produced to the world many record-breaking thoroughbreds.

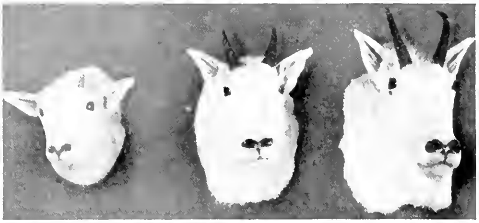


Fig. 2. A Few of the Native Aborigines Encountered in Hunting Reservoir Sites.

The eastern side of the valley is being supplied with water by a private enterprise known as the Bitter Root Valley Irrigation Company. The company has reservoired a large lake in the western side of the valley with cubical contents of some 25,000 acre feet of storage, which, together with the natural flow of streams crossed on line during early months of irrigation, it proposes to irrigate about 40,000 acres of rich fruit lands. The water is syphoned across the valley by a steel pipe six feet in diameter and thence conveyed by ditch some seventy miles, feeding numerous laterals en route.

Another enterprising company materially assisting in the development of the Bitter Root Valley is the O. W. Kerr Company of Minneapolis, Minn., whose delightful summer lodge is shown in Fig. 1. This company's holdings are situated at the upper end of the valley on the west side of the Bitter Root river.

The west side of the valley has an unusual natural supply of water. The mountains on the west side are steep and precipitous and contain numerous small lakes hidden under the brow of banks of perpetual snows. From end to end the west side is traversed about every five miles by cool, swiftly running mountain streams. These streams are not only cool and refreshing to drink, but, being loaded with trout, furnish abundant sport for those inclined toward this branch of recreation. As most of these swiftly running streams are easily diverted upon the neighboring lands, the early settlers appropriated the natural rights many times over. In the early days the lower lands of the valley were thought to be more fertile, especially for grain and hay, and as it was an easier task to construct ditches upon these lands than those higher up on the benches, nearly all the older rights in the streams belong to the lower lands.

Science has shown later that the rich bench lands back up near the break between the mountains and valley are by far the best suited to high class orchards. Here the famous McIntosh red apple is king, and Lambert and Bing cherries prove tougher in skin, due to the cool nights, and consequently better shippers than known any other place in the world.

As the streams bounding down from the high Bitter Root mountains to the west emerge through steep box canyons a new problem presents itself when the rancher endeavors to put a gravity system of irrigation upon his orchard tract. First as his land is just being reclaimed the natural flow of the stream is probably already appropriated many times over, and second, the rocky approaches from stream to land make it costly to bring water upon his land as the acreage fed by each stream is small. Hence it is first necessary for him to store flood waters to acquire necessary water rights, and second his little distributing system must be most carefully and scientifically planned.

It was the solution of this problem over and over again that caused the writer of this article to go into the high recesses of the Bitter Root mountains, get reservoir data, build dams and headgates, and finally

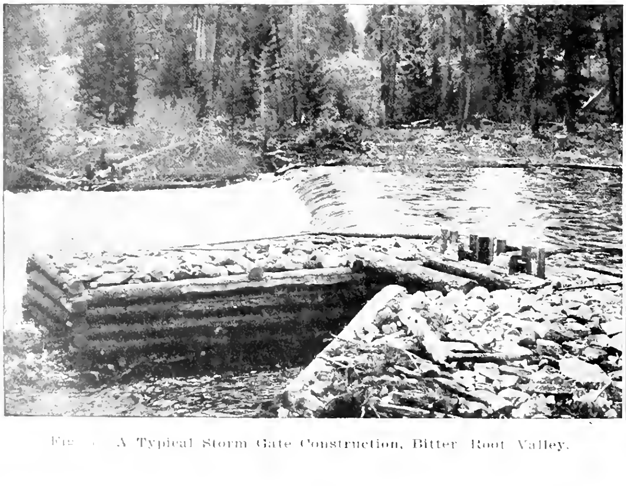
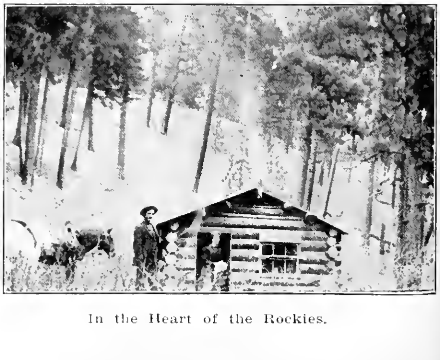


Fig. . A Typical Storm Gate Construction, Bitter Root Valley.



In the Heart of the Rockies.

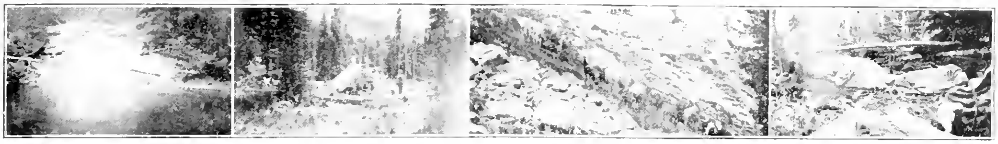


Fig. 4. A Delightful Trout Pool, a Camp in the Heart of the Bitter Root Mountains, a Construction Pack Train and Hotel de Bum, Miles From Civilization.

Fig. 5. A Twenty-Foot Rock Crib Dam in Construction at Upper Twin Lake and a Mammoth Snowslide Effect Encountered on Line.

bring the water upon the land. Many interesting little problems had to be solved, and I shall endeavor to touch briefly upon a few of these.

The best authorities consider that 24 in. of rainfall is ample in Western Montana, if carefully distributed, to properly irrigate and mature all kinds of crops. The rainy season takes place as a rule during the month of June, consequently it is considered that 18 in. of water actually delivered upon the land is ample for irrigation of all sorts. In extensive irrigation systems 12 in. is allowed for loss by seepage and evaporation, as conduits are all dirt ditches whenever possible. Hence, in laying out a typical irrigation system in Western Montana from 24 to 30 in. of water are allowed, or in other words from 2 to 2½ acre ft. per acre to be irrigated.

Due to the heavy snows in the high mountains to the west it is found that water in sufficient quantities many times over can be supplied from neighboring streams to irrigate all available lands up to July 1st, or in good years until July 15th. For orcharding it is necessary to irrigate to September 1st, or in other words, six weeks' storage must be supplied in the mountains to tide over flood-water rights in the natural stream.

By the statutes of Montana a miner's inch of water is thus defined: One cubic foot per second shall be equivalent to forty miner's inches. Let us suppose for a moment that we are looking at a stream of water. That in this stream blocks of ice measuring exactly 1 ft. by 1 ft. by 1 ft., or in a word, 1 cu. ft. in contents are floating down past our field of vision. We have a stop watch in our hands and count the number of blocks of ice that flow past us every second. Now, then, if five flow past per second the ice when melted would represent 5 second feet of water, or 200 miner's inches of water, Montana statutes.

The first settlers of the State early acquired the

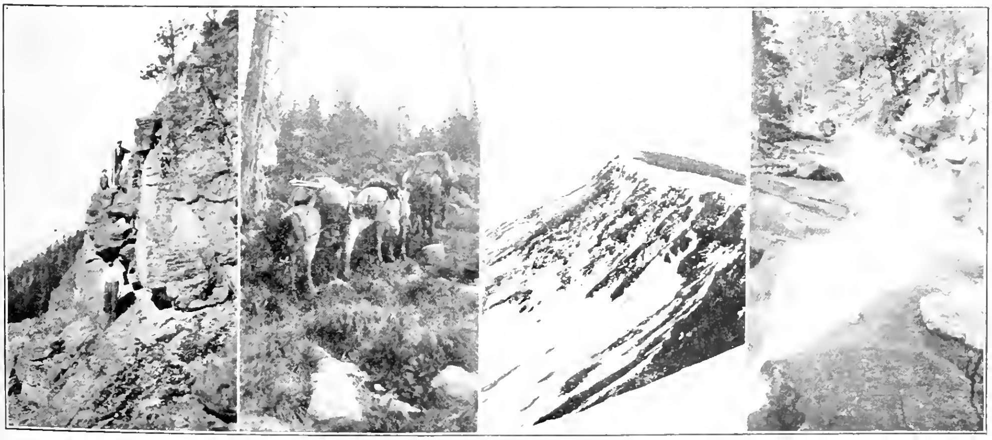


Fig. 6. Some Severe Cliff Work Along Line, an Engineer's Pack Train, the Perpetual Snows of the Bitter Roots, and a Typical Deliciously Cool Waterfall

Fig. 7. On Snowshoes Reservoir Hunting, a Typical Pack, Some Stiff Climbing and the Top of Mt. Lolo, Missoula's Weather Barometer.

wasteful habit of figuring 1 in. of water to be necessary to irrigate an acre of ground. By careful experiments at the Agricultural College at Bozeman, however, it has been found that two-fifths of a miner's inch per acre properly applied is more than ample. Two-fifths of a miner's inch of water flowing through the irrigation season will cover an acre of land approximately $2\frac{1}{2}$ ft. deep. Hence the term two-fifths of a miner's inch per acre of the natural stream flow and $2\frac{1}{2}$ acre feet of flood rights are practically one and the same thing.

In estimating the necessary storage to be acquired per acre of arid land it is considered by good authorities that if 1 acre foot of storage per acre is allowed and this, combined with part of the flood rights in an average Bitter Root Valley stream will be ample for orchard purposes.

After locating on the flood rights of the stream the next step as a rule is to see what the chances are of making cheap storage on the stream. It is to be remembered that the acreage to be irrigated as a rule usually lies between 200 to 400 acres, consequently nothing but the most economical kind of construction work is possible, for the costs soon become prohibitive when figured on costs per acre, which is the final test to be applied before the work is undertaken. To meet the common practice in the valley, the entire installation, consisting of dams, ditches, headgates, rights-of-way and everything complete, is reasonable if under forty dollars per acre, but is absolutely prohibitive if above sixty to seventy dollars per acre.

In the location of main canals and laterals up to a capacity of 25 sec. ft., a grade of 5.28 ft. per mile for main canal and 10.56 per mile for lateral is found to be best suited for the decomposed granite soil of the Bitter Root valley. In many cases it is not possible to give such grades as this. In fact, in the location of a canal below Missoula known as the Grass Valley ditch, taking water from the Missoula river and distributing it fifteen miles below, a grade as low as $\frac{1}{2}$ ft. per mile was found absolutely necessary in order to raise water where desired. The soil here was not decomposed granite, however, but a clay admixture, and consequently seepage losses slight.

The headgates are usually built in log cribs filled with rock. A favorite design in the valley is to have two gates, one for supply control and one at the immediate out-take, known as the "storm-gate." This storm-gate is not watertight, but is so built as to drain the stream entirely in low water and yet to bear the brunt of the high-water onslaught without damage. Fig. 3 is a typical illustration of a storm-gate.

The main canals are usually from 5 to 6 ft. across the bottom, 2 to 3 ft. deep, and have side slopes of 1 to 1. A variation from 1 to 1 slide slope is very unusual. In the hillside work encountered many prefer the carrying portion of the ditch to be entirely in virgin soil. As a consequence the locating engineer usually designs the lower side of the ditch so as to have a constant cut of say 2 ft. This gives rise to simplified computation of yardage, and will be illustrated later.

Flumes are built largely of wood, but the Maginnis steel flume has been found most successful in operation and is gaining in favor among the newer installations.

Fig. 8. Old Bruin Opposes Reservoiring Operations, a Glimpse of the Most Difficult Surveying on Record—Montana-Idaho Boundary, Lake Coquina—Idaho, Clearwater and Lolo Hot Springs in Dead of Winter.

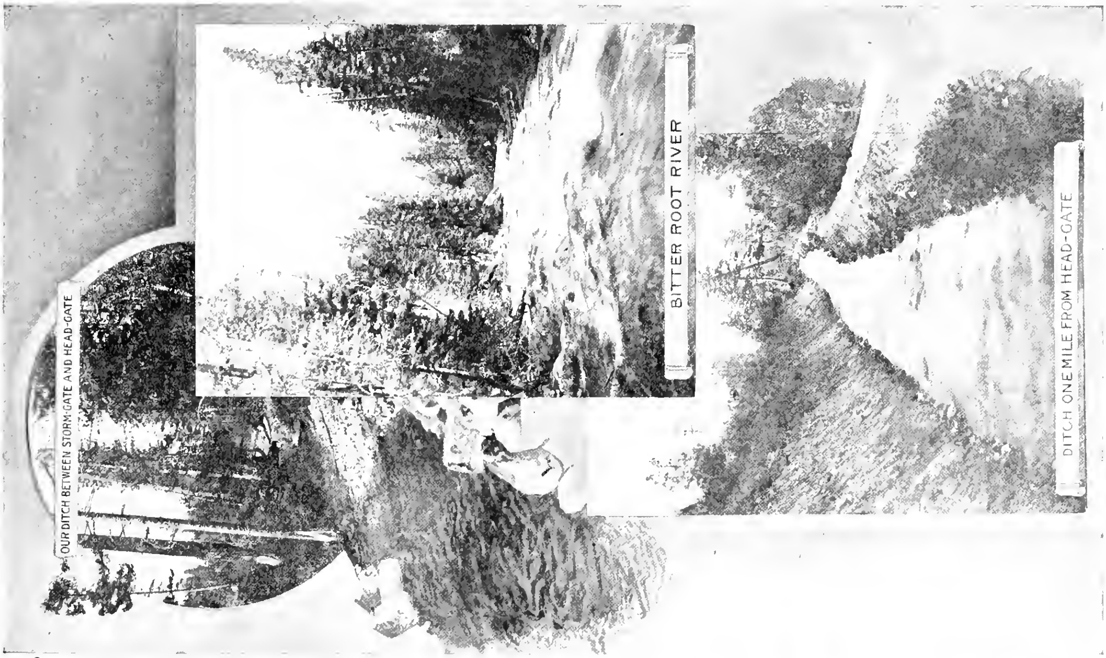


Fig. 11. Irrigation System of The O. W. Kerr Co., Bitter Root Valley

Fig. 9. Typical Orchard Scene Bitter Root Valley

Fig. 10. Distant View of Snow-clad Bitter Root Range

Fig 12 is an illustration of a stretch of Maginiss steel flume installed for the Bitter Root Stock farm which has proved highly satisfactory.

In order to make a successful trip into the heart of the Rockies in search of reservoir sites many things usually of small importance loom up as gigantic obstacles. It may be that the proposed exploration is to take place up a canyon where a well-beaten trail is situated. If so, the task is much simpler than if a trip is proposed in a canyon gorge filled with fallen timber, slide-rock, and every conceivable impediment without the least sign of a trail or means of clearing one.

anticipating pack trips into the mountains. I once heard of a gentleman who was endeavoring to journey a long way into the mountains but did not know how to throw even the "squaw" hitch, but just wound his blankets over the horse and then wound a rope around and around the horse's belly. During the first day's journey he met a prospector coming down the trail who had his pack tied in a neat "diamond." The old prospector was invited to supper, and in the course of the evening the drift of conversation finally shifted to "packs" and "hitches." The old prospector proved a walking encyclopedia in this specialized subject. He explained with such minuteness the intricate windings

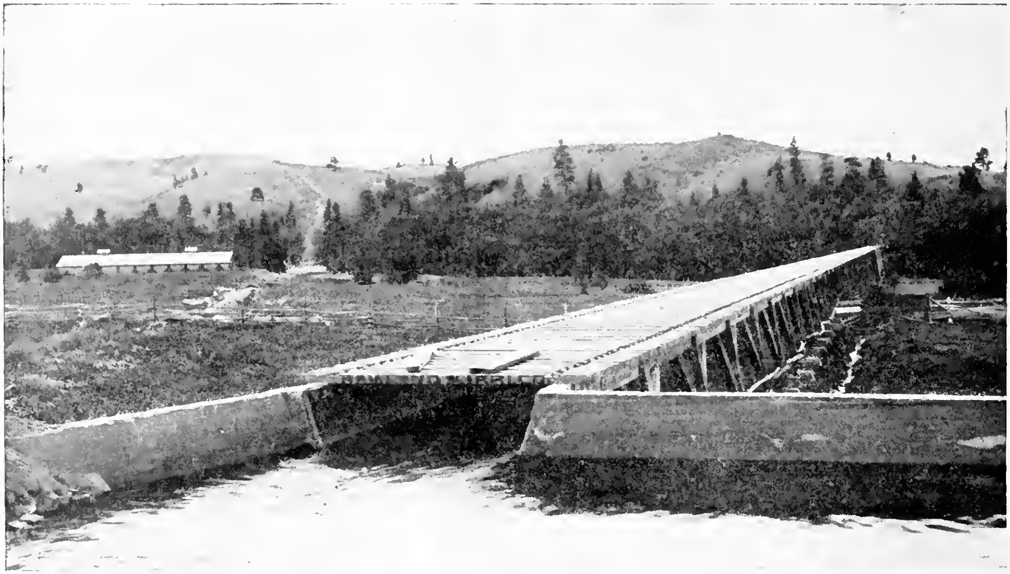


Fig. 12. Maginiss Steel Flume Installation in Bitter Root Valley, owned by the Ravalli Land & Irrigation Co., Hamilton, Montana. Flume shown is 2468 ft. long, has top diameter 8 ft. 10 in., and under a grade of 1 ft. per 1000 will discharge 184 cu. ft. per sec.

In either case each member of the party, and as a rule there are three, should have a supply of matches in absolutely watertight case, a hand-axe and a pocket transit or "Brunton." In addition, in the wilds of Western Montana, it is a good piece of wisdom for one member to pack a rifle and the other two to have revolvers strapped to their belts. Thus equipped, one is in a fair way to have heat and food if a hasty retreat is necessary, or if the members get separated distress signals can be heard.

In case the trip is to be made a-foot over rough country, as is usual in trail-less mountain canyons, each member must pack his share of the burden. A pack as indicated in Fig. 7 has been found by the writer to be the most convenient. With this arrangement three of us have packed blankets and supplies sufficient to last us for three weeks.

As stated above, the trip is rosier if on a trail and pack horses can be used. In case pack horses are available the usual query arises as to who can throw the "diamond" hitch. This is a most important accomplishment and should be mastered by everyone

of the "diamond" and "double diamond" that our gentleman friend decided to attempt it the next morning. The prospector, ever seeking for knowledge in his knot-tying hobby, told the old gentleman he would not oversee the job unless he first demonstrated the manner in which he had packed in thus far. The old gentleman quickly acquiesced and inwardly chuckled, for he saw visions of triumph that would come when he should ask the evident all-authority on hitches, the particular name of his hitch, for he knew there was none. After he had rolled the blankets over the horses back and under his belly, he then proceeded to wind and wind the rope around the horse, but hardly had he made the finishing touch when he was interrupted by an explosion from the prospector: "Wal, wal, I ain't seen the 'Oregon grape-vine' since I packed in twenty year ago for old Prof. Shelhorn, when he was studying botany in the Kootenai."

To come back seriously to the subject of packing, it has been the universal experience of every engineer whose sphere of activities leads him into a mountainous country necessitating packing in on horses that,

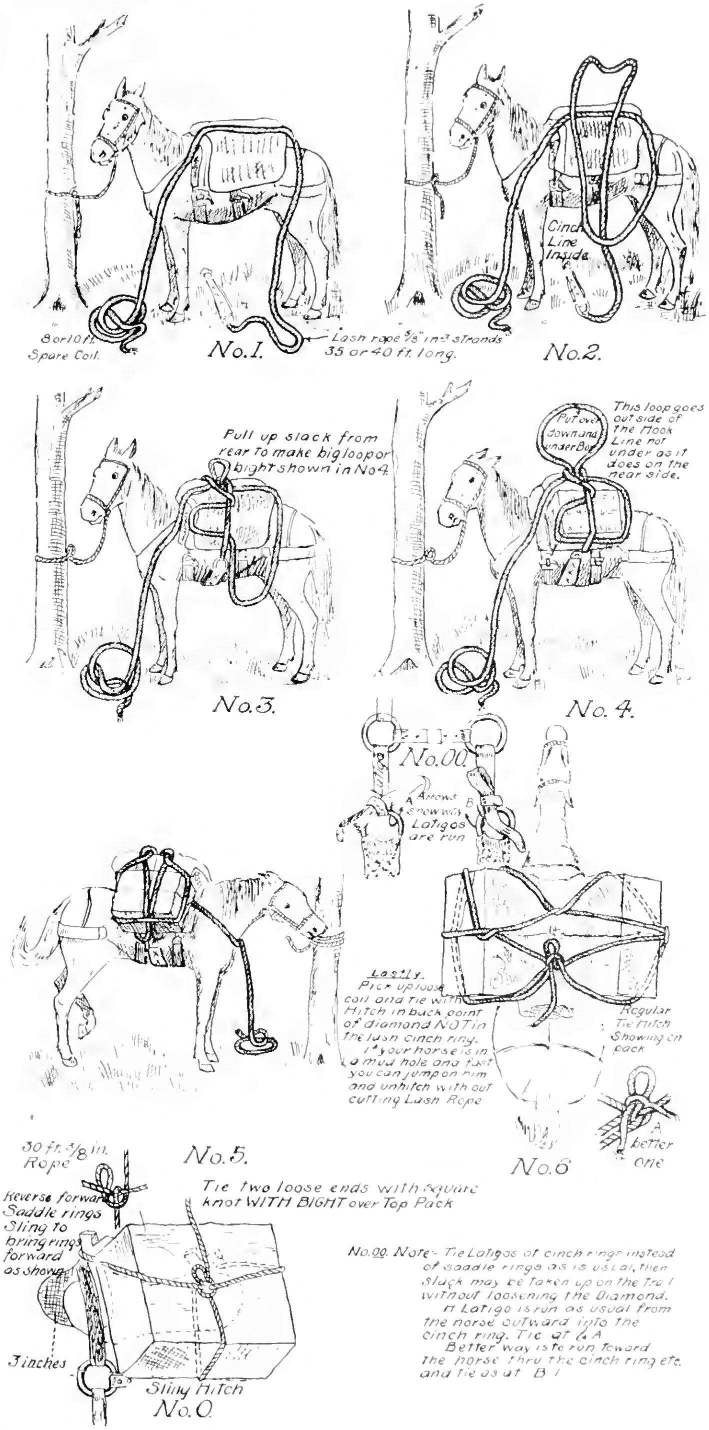


Fig. 13. Detailed Method of Throwing the "Diamond Hitch."

although the various hitches in use, including the so-called "squaw" hitch are a matter of common knowledge, yet one is thoroughly impressed with how uncommon this knowledge is when we are put right up against the problem of securing a packer to properly prepare the horses for a dangerous mountain trail.

Some three years ago there was a sudden demand for large numbers of pack horses and packers to take surveying crews into the great Idaho clearwater over to the west of the Bitter Root Mountains. A location war was on between the Northern Pacific company and the Harriman lines as to who should control the Lolo pass from Idaho into Montana. So great was the demand for packers that they were obtained with difficulty, consequently some of the engineering force were assigned to this august post. Orders were issued and each pack train furnished with a blue print of the "diamond" hitch as illustrated in this article. It proved of immense service in the quick dispatching of supplies. It is a good plan for every practicing engineer whose duties call upon him to go into a country necessitating pack trains, to get out behind the barn and master one good secure form of hitch for packing, preferably the "diamond" or the "double-diamond," if he desires to pack instruments at any time.

The illustration shown in Fig. 6, shows a diamond properly made, but not sufficient care in placing the level rod upon the horse, consequently the rod was broken by the horse running into a tree at a narrow passage in the trail.

The third illustration, in Fig. 7, shows a method of rolling blankets and packs for a severe trip into a very inaccessible country. The equipment thus packed on shoulders allows the highly furnished camping apartment shown in Fig. 4.

The method of pitching a tent by cross-arm supports for the ridge-pole shown in the second illustration in Fig. 4, is convenient and thoroughly safe, although not so artistic as upright support and side lashes.

Finally, it is the mastering of the little details of camp life that make all the hardships bearable and with these mastered, the engineer is not only able to become an expert in reservoir hunting, but withal finds time to commune with the great unfoldings of nature en route, an enjoyment so unique and exquisite only those who have experienced it can tell.

HORSEPOWER DEFINITION.

BY A. I. E. E.

In view of the fact that a horsepower defined as 550 foot-pounds per second represents a power which varies slightly with the latitude and altitude (from 743.3 to 746.6 watts) and also in view of the fact that different authorities differ as to the precise value of the horsepower in watts, the Standard Committee has adopted 746 watts as the value of the horsepower. The number of foot-pounds per second to be taken as one horsepower is therefore such a value at any given place as is equivalent to 746 watts; the number varies from 552 to 549 foot-pounds per second, being 550 at 50 deg. latitude (London), and 550.5 at Washington.

NEWLY-ELECTED WESTERN MEN A. I. E. E.

The following western men were elected as associates in the A. I. E. E., on June 27, 1911:

Louis Samuel Baird, engineer, Adams-Bagnall Electric Company, 600 Huron Road, Cleveland, Ohio.

Robert Almon Balzari, salesman, Westinghouse Electric & Mfg. Co. 165 Second street, San Francisco, Cal.

James Milne Barry, assistant, underground electrical distribution department, Pacific Gas & Electric Co., Sacramento, Cal.

John Wesley Bowdle, superintendent of equipment, San Diego Home Telephone Co., San Diego, Cal.

Frank J. Brann, construction foreman, Ford, Bacon & Davis; residence, 3724 Army street, San Francisco, Cal.

Howard Edwin Brillhart, station foreman, Great Falls Power Co., Anaconda, Mont.

Albert F. Cooke, electrical engineer, Mt. Hood Railway & Power Co., 604 Lewis Bldg., Portland, Ore.

Clyde Lindsly Davis, electrical engineer, Tonopah Mining Co., Tonopah, Nev.

Clarence Earl Fleager, division plant engineer, Pacific Telephone & Telegraph Co., 86 West Mission street, San Francisco, Cal.

Arnt Jacobsen, electrical machinist, Seattle-Tacoma Power Co.; residence, 1017 Jefferson street, Seattle, Wash.

Samuel Macaw Kennedy, general agent, Southern California Edison Co., Los Angeles.

Frank Earl Marcy, district manager, Allis-Chalmers Co.; residence 74 P street, Salt Lake City, Utah.

John James Marshall, assistant superintendent of machinery, United States Mint, San Francisco, Cal.

Hammond Mathews, chief electrician, Arizona Copper Co., Clifton, Arizona.

Louis Clifford McIntosh, assistant manager, Southern Pacific General Telegraph, 488 Pacific Electric Bldg., Los Angeles, Cal.

Thomas McLean, meter tester, Los Angeles Gas & Electric Corporation, 645 South Hill street, Los Angeles, Cal.

Albert Franklin Menzel, construction foreman, General Electric Co., Nevada Bank Building, San Francisco, Cal.

T. G. Quinn, superintendent, Alaska Water, Light & Tel. Co., Valdez, Alaska.

Frederick P. Rawson, electrical engineer, Mt. Hood Railway & Power Co., 608 Lewis Bldg., Portland, Ore.

George Walter Shaver, engineer, Westinghouse Electric & Mfg. Co., 165 Second street; residence, 1032 Thirty-third avenue, Oakland, Cal.

Charles Alexander Turner, electrical engineer, Pacific Telephone & Telegraph Co., 140 New Montgomery street, San Francisco, Cal.

Erle Leroy Veuve, consulting engineer, 693 Pacific Electric Bldg.; residence, 177 Ardmore avenue, Los Angeles, Cal.

Markham Cheever, in charge of chief engineer's office, Telluride Power Co., Provo, Utah.

THE ELECTRICAL PRECIPITATION OF SUSPENDED PARTICLES.[1]

BY F. G. COTTRELL.

The removal of suspended partcles, from gases, by the aid of electrical discharges is by no means a new idea. As early as 1824 we find it suggested by Hohlfeld as a means of suppressing ordinary smoke, and again a quarter of a century later by Guitard. These suggestions, which do not seem to have stimulated any practical study of the question, were soon entirely forgotten and only brought to light again by Sir Oliver Lodge many years after he himself had independently rediscovered the same phenomena and brought them to public attention in a lecture before the Liverpool Section of the Society of Chemical Industry, November 3, 1886.

Some four years ago while studying various methods for the removal of acid mists in the contact sulphuric acid process, the author had occasion to repeat the early experiments of Lodge and became convinced of the possibility of developing them into commercial realities. The work described in the present paper may fairly be considered as simply the reduction to engineering practice as regards equipment and construction of the fundamental processes long since laid open to us by the splendid pioneer work of Lodge, a feat vastly easier today than at the time of Lodge and Walker's original attempt.

The precipitation of suspended matter whether in gases or liquids may be accelerated by electricity in the form of either direct or alternating current, but the mode of action and the type of problem to which each is best applicable differ in certain important respects.

Where an alternating electromotive force is applied to a suspension the action consists for the most part in an agglomeration of the suspended particles into larger aggregates out in the body of the suspending medium and a consequently more rapid settling of these aggregates under the influence of gravity.

Alternating current may thus be used to advantage where the masses of gas or liquid to be treated are fairly quiescent and a simple agglomeration of the suspended particles into larger aggregates is sufficient to effect separation by gravity or otherwise.

In the case of the large volumes of rapidly moving gases in smelter flues the agglomerating and settling process is, however, too slow even when the flues are expanded into as large dust chambers as are commercially feasible. It is in such cases that direct current methods have been particularly important.

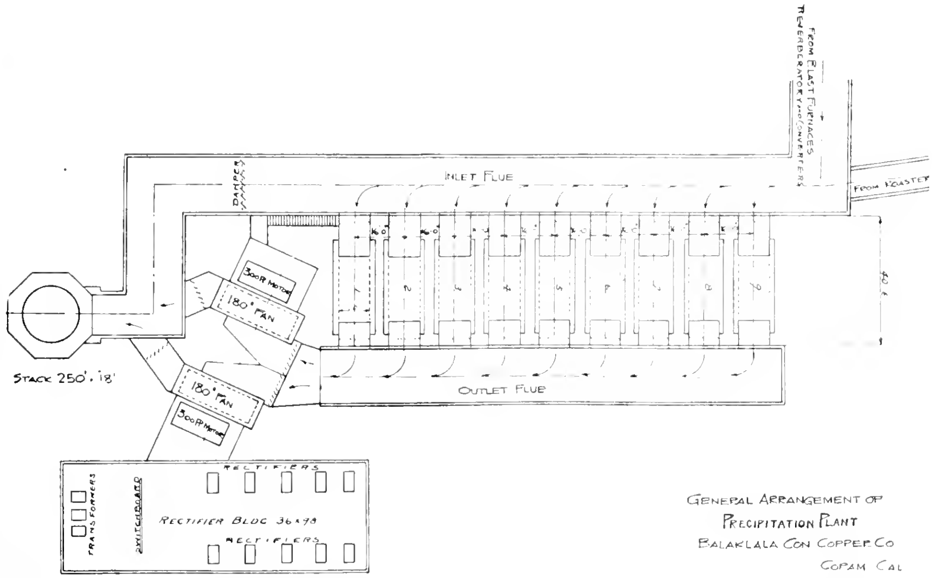


Fig. 1. Plan of Nine Electrical Precipitation Units.

The Balaklala, or First National Copper Company, is the most recent of the Shasta County smelters, having blown in its first furnace in 1908.

These smelters are all situated in the narrow precipitous canyon of the upper Sacramento River and its tributary, the Pitt. The region itself is too steep and rocky for agriculture but was once heavily wooded, although now swept bare of vegetation for miles. As far as the canyon itself is concerned probably all the damage possible has already been done unless reforestation were undertaken. This latter even would probably be slow and difficult work as since the loss of vegetation the steep hillsides have been washed bare of soil for miles around. At Redding, however, some thirteen miles below Coram and seventeen miles below Kennett, the canyon widens out into the fertile Sacramento valley and from this point southward for some twelve miles further lies the region from which for the past two years have come increasingly insistent complaints against the smelters. These culminated a little over a year ago in agreements between the farmers and the

[1]Abstracted from The Journal of Industrial and Eng. Chem., August, 1911.

smelters under which friendly suits were brought in the federal courts and injunctions issued by stipulation requiring the smelters to remove the suspended matter from their exit gases and dilute the latter to such an extent that their sulphur dioxide content should not exceed seventy-five hundredths of one per cent by volume as discharged from the stacks, with the further general and sweeping provision that they should do no damage.

Fig. 1 is a plan of the nine electrical precipitation units or chambers in their relation to the flue system and stack. It should here be noted that the two large fans indicated in the drawing are not required for the operation of the precipitating system nor to overcome any added resistance due to its introduction, as this latter is very slight indeed. The fans were made necessary by that section of the court's decree requiring dilution of the sulphur dioxide to three-quarters of a per cent or less. When the furnaces are running on a high sulphur charge this feature of the decree necessitates a considerable dilution of the gases with fresh air and corresponding diminution of stack draft. At these times the fans are operated, but during a considerable portion of the time the sulphur dioxide in the gases can be brought low enough without interference with the draft, and during these periods the fans are stopped entirely although the gases still pass through them.

At the rectifier building the current is received from the companies' three-phase power circuit at 2300 volts 60 cycles, and after being transformed up to from 27,000 to 30,000 volts under the control of the operator through variable resistance and induction regulators is rectified into an intermittent direct current as aleady explained and distributed to the individual preciptating units.

Fig. 2 shows a cross section through one of these units or precipitating flues as first installed. The double vertical lines represent the collecting or grounded electrodes each 6 in. wide by 10 ft. high made of No. 10 sheet iron. The dotted lines represent the discharge electrodes consisting of two iron wire strands between which is twisted the discharge material, for which both asbestos and mica preparations have been used in this plant. Each unit contains 24 rows of 24 electrodes of each type. The collecting electrodes are carried by bars connected directly to the frame of the chambers themselves while the discharge electrodes are spanned by springs between a system of buss bars carried on externally placed insulators as shown in the figure. To the auxiliary chambers surrounding these insulators a small regulated amount of air is admitted to prevent conductive dust or fume from working back and settling on the insulators.

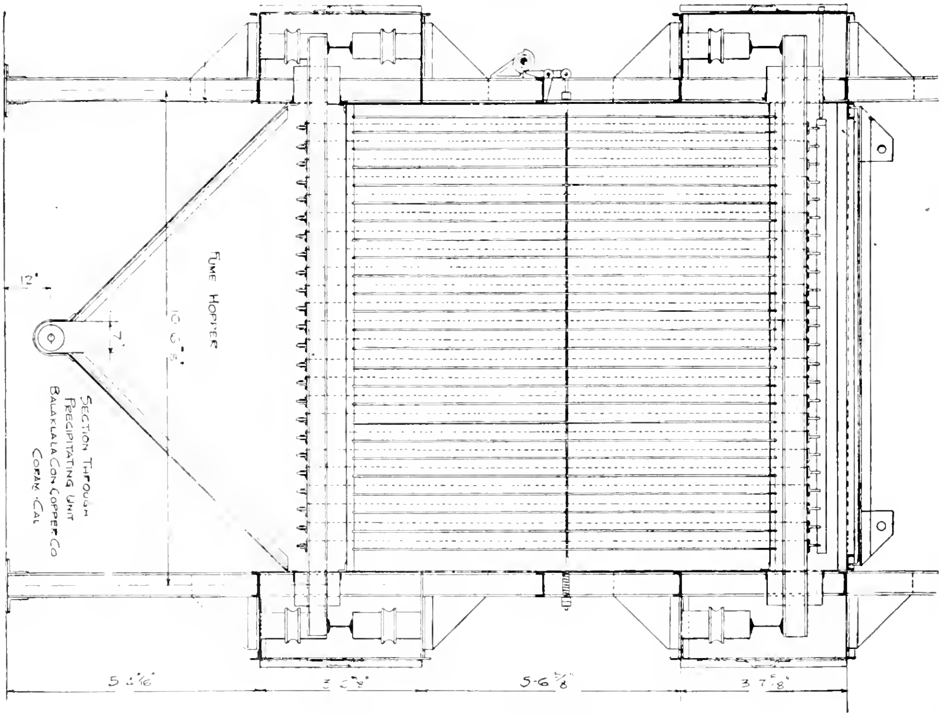


Fig. 2. Cross-section Precipitating Unit.

The cam and shaker rod extending across the middle of the unit was originally designed for the purpose of vigorously shaking the electrodes as it was greatly feared that the removal of precipitate from the electrodes in units of this size might be one of our most serious problems. In actual operation it has been found however that the electrodes can easily be shaken by hand from the top entirely free from dust, the whole operation including cutting the unit in and out of the

system and the removal and replacement of its covers requiring only about ten minutes, and this having to be repeated every six or eight hours, depending on the dust content of the gases. The precipitated dust and fume as it falls from the electrodes is carried by the conveyor in each unit to a common longitudinal conveyor which in turn discharges into cars carrying it away for treatment and recovery of its values.

Filtration tests show that this plant under favorable working conditions precipitates between 80 and 90 per cent of the suspended matter in the gas, the average over the whole period of operation to date being somewhat less. Under present operating conditions at the smelter this represents some six to eight tons of precipitate per 24 hours.

The gas treating plant as a whole including flues, fans, motors and electrical apparatus cost up to the time it was first put in operation a little less than $110,000. Although many minor changes have since been made none of the larger or more expensive elements of construction have been greatly altered.

The total average power consumption for the precipitation plant at present is in the neighborhood of 120 kw. One man can readily control the whole operation in the rectifier house although as a matter of precaution for a new plant under the high tension here used two have usually been on duty. Two laborers and a foreman are employed on the precipitating units and dust-handling system, although this can probably be reduced somewhat by automatic shaking devices, since as yet the main efforts at improvement have been directed elsewhere.

The volume of gases to be treated varies considerably with the conditions at the furnaces, but at present may fairly be taken as averaging between 200,000 and 300,000 cu. ft. per minute, and entering the units at from 100 to 150 degrees C.

One of the greatest difficulties met with in this particular installation has been the maintenance of conductivity in the fine fibers of the asbestos and mica of the discharge electrodes. At ordinary room temperatures these materials readily take on enough moisture from the air to afford sufficient surface leakage for all the discharge necessary, and the same is true at higher temperatures if the gases contain traces of sulphuric acid or other conductive matter, but in the particular gases here met with the high and variable amount of zinc oxide at times robs them of all conductive matter, thus reducing the conductivity of the fibres of the electrodes and seriously effecting their efficiency. The possible methods of overcoming this and giving the fibers a permanent conductivity of their own as well as other details of the more purely electrotechnical matters underlying the whole process will be treated more at length elsewhere as the present article is intended more as an outline sketch of the history and practical development of the work thus far accomplished. Nor is this the place to speculate upon the final outcome of situation between the farmers and the two great smelting plants which have adopted the remedial measures above described, for this is in the end a question for the botanical and agricultural expert, as to whether or not, or to what extent actual damage is still being done, no matter whether this comes from suspended matter or from the sulphur dioxide, which neither the bag house nor the electrical precipitation make any claim to remove. The two smelting companies have done and are doing everything in their power to better the conditions while on the other side the farmers, through the executive committee of their protective association, have earnestly tried to carry out their part in a spirit of fairness to all concerned.

To those who know the circumstances of the many bitter conflicts between farmers and smelters all over this country, with the attendant expense and usual barrenness of results, the present developments in Shasta County present a very suggestive illustration of what may be accomplished in the technical development of our industries by spending the money on experiment and construction instead of all on litigation. Irrespective of the local issues involved the work done at both of these smelters during the past year has been a real and decided step forward in practical metallurgy. Both plants have already sufficiently demonstrated the applicability to large scale operation of the principles underlying them to ensure these principles finding a permanent place from now onward in the field of engineering, and each for the particular cases for which it is peculiarly adapted. Before us, of course, still looms the question of the sulphur dioxide and the solution for this on an equally large scale is unfortunately not yet clearly in sight.

Of the other possible applications of the process, one of the most recent to be actively prosecuted is the collection of dust from Portland cement kiln gases. The chief stimulus to this development has again been the nuisance to the surrounding population and its attendant litigation. This has been especially acute in Southern California where several cement plants are located in the heart of an exceedingly rich orange country. In the case of the Coulton plant with a capacity of 2500 barrels a day an injunction has already been issued by the court which, if sustained, will close the plant, unless they can control their dust, which the court estimates at present at some 20 tons per day. This case differs from that of the smelters in that here there is no question of damage from gases but merely the deposition of a large tonnage of impalpable dust of lime and clay.

From the technical side a new condition is here met with in the high temperature of the gases to be treated, which are 450 degrees C. and upwards as they leave the present stacks. The dust itself is furthermore entirely devoid of electrical conductivity, but notwithstanding this it is easily and completely precipitated by the electrodes when these are properly adapted to the new conditions.

Another extensive field in which it is hoped this process may find useful application is the cleaning of iron blast furnace gas for use in gas engines. Outside of the poisonous and combustible nature of these gases and the consequent necessity for keeping the whole apparatus gas-tight there would appear to be no new difficulties here to overcome and steps are being taken to thoroughly test the matter on a practical scale, this work at present being in direct charge of Mr. L. L. Johnson of Indianapolis.

A question which naturally presents itself is whether this work has any bearing upon the coal smoke problem of large cities. In answer it may be said that for the great majority of cases at present the more logical line of attack would seem to lie in improved methods of combustion, to avoid making smoke in the first place, but in some special instances where such methods may happen to be particularly difficult of application and the suppression of smoke is especially desirable, electrical precipitation may eventually be found of use, for experiments show that it acts upon ordinary smoke in essentially the same manner as upon the fumes and dust above discussed.

Note Received July 7, 1911.

Since the manuscript of the above article was sent to the printer the case of the Balaklala Company vs. the Shasta farmers has come up for formal hearing in the United States Circuit Court in San Francisco, before Judge Morrow, on June 19th.

The evidence presented from the farmers' side consisted of a considerable number of affidavits from individual residents of the district in question, stating that they believed damage was still being done. They naturally made little or no attempt to distinguish between damage from gases and that from suspended matter. Of much more interest in the present connection was the report from Messrs. Gould and Burd, the chemists employed by the Shasta County Farmers' Protective Association, to examine the operating conditions at the smelter itself and determine to what extent the terms of the decree were being fulfilled.

Their tests extended over the period from March 10th to April 3d and credit the electrical apparatus with removing during that period an average of 72.8 per cent of the total solids in the gases entering it. In nearly one-third of the individual determinations the removal of solids reported is over 85 per cent.

They report the average concentration of sulphur dioxide as 0.56 per cent by volume, but state that several times during the month the concentration rose slightly above the 0.75 per cent prescribed as maximum by the court.

The outcome of the hearing was the entering of a judgment by agreement and stipulation between the contesting parties whereby the plant is allowed thirty-five days under existing conditions in which to run through the ore on hand, but is then required to close down completely until such time as it can live up to the letter of the original decree, viz., remove all solids, never exceed 0.75 per cent sulphur dioxide and do no damage.

During the time in which the plant still remains in operation experimentation and development is being carried on as vigorously as ever, but it is scarcely expected even under the most favorable conditions that a shut-down can be entirely avoided. During such shut-down, however, the progress of the work at other plants already undertaken thoroughly insures the uninterrupted development of the process in general.

The Panama-Pacific Exposition, San Francisco, 1915, means commercial supremacy for the West. If you never thought of this before, explode a keg of dynamite and wake up.

BILLIARD TABLE LIGHTING.

BY F. W. LOOMIS.

In looking over the lighting systems for billiard and pool tables in service at clubs, hotels and public billiard rooms it is surprsing to see how abominably the majority of tables are illuminated.

In many rooms one sees the old four light fixture still in service, the lights placed in a form of a cross—two arms of fixture running the length of, and two across the center of table, with lamps in horizontal position and but partially shielded. The corners of the table are usually most inadequately illuminated.

Again a system is used where three lights are placed over the center of the table's length, usually covered with a non-reflecting material such as art glass. This system gives no distribution, but only a bright streak in the center line of the table. But we have all probably seen and noted the poorly lighted examples, so let us now give thought to how to improve on the faults.

Billiard and pool service requires about 4.0 to 5.0 foot candle intensity of local illumination evenly distributed over the surface of the table with a geneal intensity over the room of 0.8 of a foot candle.

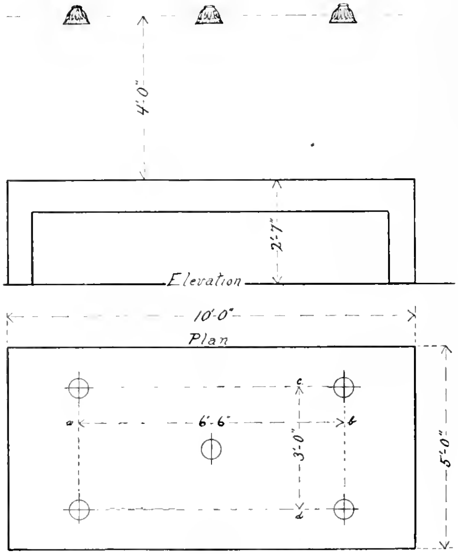


Fig 1.

Fig 1 shows a suggested system of five light sources properly spaced to give an even distribution of light using 32 candle power lamps. This is one of the most attractive systems from the standpoint of both appearance and evenness of illumination that has been devised, and for club, hotel and home service is most satisfactory. The system takes care of the general lighting of the room, and also gives the strong local illumination required over the table. It will be noted that the table shown is the standard 5 ft. by 10 ft. Should the 4¼ ft. by 9 ft. table be used the spacing of units must be changed slightly. The dotted

line a-b should then be 6 ft. 0 in., while c-d is 2 ft 9 in., the mounting height of 4 ft. remaining the same.

The five light sources can be attractively linked together by a looped chain effect, while if so desired, an art glass envelope may cover each reflector. Of course, this system may be too expensive in a large public hall having many tables, consequently, scheme shown in Fig. 2 is submitted.

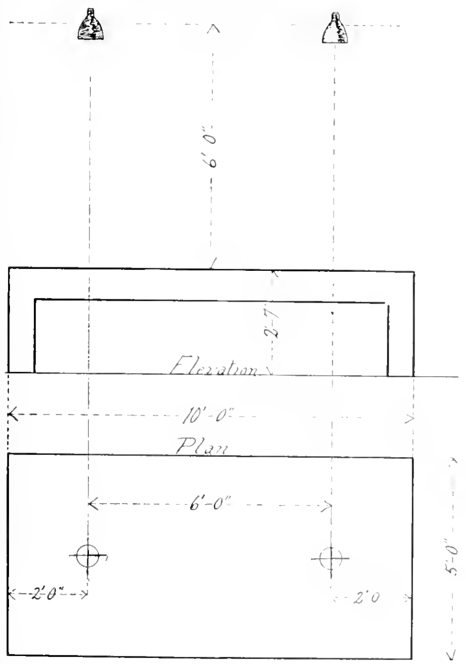


Fig. 2.

This plan calls for but two light sources over each table. Here 48 candle power lamps are recommended under steel reflectors. Augmenting this system, which is strictly for the local illumination, there should be some general lighting scheme of mild illumination over the balance of the room, preferably using glass reflectors. These general lighting sources should be placed well up toward the ceiling of the room.

The equipment recommended for Fig. 1 is as follows:

Five 40-watt bowl-frosted Mazda-tungsten lamps with form "O" (standard 2¼ in. shade holders) and E-40 satin finish Holophane reflectors. These may be used with or without art glass or other fancy envelope. This system will give an average intensity of 4.25 foot candles illumination over the playing surface of the table.

Equipment for Fig. 2 consists of two 60-watt bowl-frosted Madza-tungsten lamps, each covered by a Holophane D'Olier steel reflector AI-60. This will give an average intensity of 4.0 foot candles on the table. By lowering the units two feet (mounting height reduced to 4 ft. above table) two 40-watt bowl-frosted Mazda-tungsten lamps may be used with Holophane D'Olier steel reflectors AE-40. The results, however, will not be quite so good as the intensity will be reduced to about 3 foot candles. Also at 4 ft. mounting two 60-watt bowl-frosted Mazda-tungsten lamps may be used with form "H" holders and E-60 satin finish Holophane reflectors. These will give less than 3 foot candles intensity, however, though no other lighting will be needed for general effect. Where the (Fig. 2) two light system is used over a 4½ ft. by 9 ft. table the spacing between the light sources should be maintained.

CITY ABLAZE WITH MYRIAD LIGHTS.

BY R. M. WHITNEY.

One of the most brilliant electrical expositions ever given in the world, will be held in Los Angeles at Fiesta Park, November 25 to December 9, if the plans of the Executive Committee, selected from the representatives of Los Angeles electrical companies, do not go astray. Plans for the great show were launched at a dinner of the electrical men recently.

The committee selected at the meeting recently consists of H. B. Woodhill, chairman; C. S. Walton, vice-chairman; C. G. Pyle, secretary and treasurer; and J. E. MacDonald and T. E. Burger, associate members. The entire affair will be under the general management of D. M. Moses, who has had charge of similar expositions in other cities, and who gave the first automobile show ever held on the Pacific Coast at San Francisco in 1907.

Fiesta Park is to be overarched by a great canopy of waterproof canvass, and the poles will be covered with silks in which vari-colored lights will be embedded. More than 40,000 incandescent lamps will form only a portion of the illumination of the large tent. The 90,000 square feet of space will be divided by avenues and booths in which will be given demonstrations of every apparatus in the electrical world since the lightning was first stolen from the heavens, to the present time.

The railway companies have agreed to decorate their cars with extra illuminators during the two weeks of the show, and many business firms of the city will assist in adding special contributions to the brilliant affair.

"The show will probably cost close to $100,000," said Mr. Moses yesterday, "but it will be worth it, and more, to Los Angeles and to Southern California. Not only will the electric companies of this section be represented, but many of the large eastern concerns will purchase booths in the big tent. Fiesta Park, which we have selected, is one of the very best settings for such an exhibit I have even seen, either in this country or in Europe. There is no reason why this affair should not be held annually. Similar expositions have been going on every year in Chicago for eight years and in New York for the last six years. Boston, Denver, Minneapolis, Pittsburgh and San Francisco each held an electrical exhibit last year, and these cities will make them annual occurances. There could be no better city in which to hold such an exhibit and we intend to make it a success."

JOURNAL OF ELECTRICITY
POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Western Power Rivalry

It has recently been commented upon by the Financial World of New York that scarcely a week passes by but that either the Great Western Power Company or its rival the Pacific Gas and Electric Company makes some sort of a move against the other. The new financing by the Pacific Gas and Electric involving something like ten millions for extensions and improvements is now followed by an announcement that the Great Western Power is edging its way into cities and towns around San Francisco and selling power in territory heretofore considered to belong to the Pacific Gas and Electric.

It is patent that both companies are expecting great things of the Panama Exposition in San Francisco on which work has already begun. The people of the State are preparing for a veritable boom and it is to be an occasion to advertise the State which will be taken full advantage of. As a matter of fact, bids for the inflow of large amounts of foreign as well as additional American capital are now being made and response has been most gratifying. Both Swiss and French capitalists have betokened a lively interest in the possibilities of the State.

When it is considered that the great State of California is three times the size of the whole of England and yet has but seven per cent of England's population, we can in a small measure get an insight into the immediate future of this great commonwealth. The combined future power output of these two great corporations means a possibility of nearly three-quarters of a million horsepower, a sum almost too startling to comprehend, yet even more wonderful has been the unprecedented growth of the developed resources of this State during the past decade. No one would dare say there is not a strong possibility that before these power resources are fully developed the growth of the State will necessitate even more gigantic development over even longer distances.

Good Roads Activity

In the days of Roman supremacy in order that a revolution or insurrection might be quickly subdued by rapid transit of troops it became an absolute necessity from a military point of view to connect Rome with all parts of the Empire by perfect roads. These roads were constructed with such care for permanency that the old Appian Way and the many other similar public boulevards that gave rise to the adage "all roads lead to Rome" are still the marvel and admiration of engineers the world over.

During the next five years the entire West will be preparing to put itself on exhibit to the world and come into its own in the way of commercial supremacy. The way to capture commercial supremacy is to so prepare our natural exhibits that they will be accessible without too severe physical exertion. The final clincher that is to hold permanently in our country the admiring visitors of 1915 is, after they have seen the great exhibits of the fair, to show them our most substantial exhibit, the great undeveloped resources of the West.

The advent of the automobile has revolutionized

sightseeing. All the benefits that are derived from "seeing in order to believe" are acquired without the terrific physical strain formerly endured in getting an insight into the natural resources of a county. To give the automobile its full value we must improve our roads. For best results there should be a thoroughly good substantial highway beginning at the Yellowstone National Park in Montana; continuing thence through the Bitter Root Valley to the Flathead and the Glacier National Park; thence to Spokane, the Yakima and other sights of the Inland Empire; thence over the picturesque Cascades to Seattle and Tacoma; thence through the gigantic timber belt to Portland; thence southward through the scenic Rogue River country, past Mount Shasta, down the lovely Sacramento Valley to San Francisco; thence southward along the beautiful coast scenery to Santa Barbara; thence to the enterprising city of Los Angeles and southward to the San Diego exposition. Should such an enterprise be attempted with side roads to the Big Trees and the Yosemite Valley and the thousand other wonders of the West, it would undoubtedly .neet with the hearty support of all the states through which it would pass, and if thoroughly advertised to the world it would unquestionably be patronized by thousands and result in a valuable widespread knowledge of the whole West.

The Western States are already alive to the keen necessity of improvement in roads. The Montana Good Roads Congress which convened at Helena on June 27th declared itself in favor of the proposed highway from the Yellowstone National Park to the Glacier National Park and recommended that courses be given in the technical schools of the State covering public road engineering features. In Idaho the Intermountain Good Roads Association met in convention at Pocatello, Idaho, on June 23-24, and recommended to Congress through their delegate, ex-Governor Brady, the passage of a bill setting aside one million acres of land in each State for the systematic development of public highways. The executive committee of the Oregon State Grange which recently met at Corvallis is in close touch with Governor West and is drafting two good road bills to be submitted to the voters of the State at the general election in November, 1912. In Washington the Pacific Highway Association is very active in promoting the subscription of thousands of dollars in road improvement throughout the State. In California hardly a day passes that we do not read of civic bodies in various conventions throughout the State declaring for better and more efficient roads. Desire for better roads is beating in the breast of every true Westerner.

Let us have uniformity and co-operation and the world is ours.

Smelter Smoke Nuisance

Elsewhere in these columns will be found an article dealing with the abatement of the smelter smoke nuisance and an account of some actual results accomplished. The question is of vital interest to the entire West. The past fifteen years have witnessed the spending of enormous sums of money in costly litigation, too often with no fruitful results credited to either side. The practical cases solved or partially solved in the article referred to, deal with California smelters but the cry of far-off Utah and Montana is often heard in these controversies.

In the past too much impatience is often shown on the part of the farmers to have an immediate abatement of the nuisance and on the other hand too much high-handed disregard on the part of the owners of the smelters in their attempts to scientifically solve the question. A new awakening seems to be gradually coming over both parties to the controversy. A few years back the owners of a certain large smelter, in fact a smelter in many respects the most powerful in the world, were sued for damages by farmers for miles around. The court awarded heavy damages and an abatement of the nuisance for the future. The owners in their efforts to meet the order of the court built a new smelter nearby and the design of the new stack was so large and was so powerful it was fully expected the evil effects of smelter smoke would be forever conquered. One of the up-holders of the smelter interests proudly prophesied that the dissemination of the smelter smoke would be so complete, due to the high velocity of the issuing gases, that the upper currents of air would distribute it over the whole surface of the earth similar to the phenomena subsequent to the explosion of Krakatoa in 1883. The explosion of this island near Sumatra was so severe, its effects were felt in London on the opposite side of the earth and small suspended particles in the upper air currents made brilliant sunsets in far off Africa. In their enthusiasm over the size and power of the new stack, farmers for miles around were invited by the managerial department to hold a dance, it is said, inside the big stack which measured over 105 ft. in inner circumference. Only a few years passed by, however, before the same old cry was heard on all sides, though this time from a wider area. It is evident then, the only solution that will be final will be the effectual removal of the obnoxious substances from the escaping gases.

In the issuing of an injunction by the court against the smelter if real damage has been done the farmer some good to him is undoubtedly brought about by the cessation of the nuisance. In this latter day thinking, however, the question must be carefully considered as to which is the greatest good to mankind, the great industry thus threatened or the curtailing of the output of a few adjacent farms. In the suit of the Deerlodge farmers of Montana against the Washoe Smelter, had the court granted the injunction, the greatest industry of the state would have been paralysed and thousands of people would have had to go hungry or seek employment in other states. Not only would the industry itself have felt the effect but practically every financial institution in the state would have suffered.

But the main question to be solved is how to arrive at a completely scientific means of handling the obnoxious gases. Great strides have been made in its solution in the past ten years. The problem will never be solved by injunction without allowance of liberal time for experiments on means of prevention. All great accomplishments have required time to bring them about. We read in the Good Book that to create the world six days were required by even the Almighty.

PERSONALS.

William Clayton, an official of the San Diego Electric Railway Company, is a San Francisco visitor.

W. S. Iliff of the United States Light and Traction Company of Denver, was a recent arrival at San Francisco.

George Hewitt Meyers, engineer with the United States Department of the Interior, arrived at San Francisco during the past week.

Charles B. Dixon, who has been associated for a long time with Thomas A. Edison at East Orange, N. J., is a recent arrival at San Francisco, en route to Honolulu, on a vacation trip.

A. C. Balch and W. G. Kerckhoff, of the Pacific Light & Power Company, came up from Los Angeles to be present at the recent festivities of the Bohemian Club at Bohemian Grove.

F. B. Gleason, manager of the Western Electric Company's Pacific Coast branch, left last Tuesday for a month's business tour of the East. He will attend the National Jobbers' Convention at Saratoga.

H. H. Sinclair, who has general supervision of the extension work of the Great Western Power Company, including the great impounding dam at Big Meadows, recently came up from his home in Southern California and visited the scene of operations.

George S. Hewins, one of J. G. White & Co.'s engineers, spent a day at San Francisco last week and then proceeded to the Big Creek watershed to make an investigation for the Big Creek Power Company with a view to installing two hydroelectric plants.

Sidney R. Inch, manager of the Missoula Light & Power Company of Missoula, Montana, left on August 16th for a visit to his home city, London, England. Mr. Inch has not been home for ten years, so that his sixty-day sojourn abroad has many pleasant anticipations, not the least among which is his anticipated visit with his former friend and instructor, Professor S. P. Thompson.

Robert Sibley, editor of the Journal of Electricity, Power and Gas, has been recently appointed by the Regents of the University of California, Associate Professor of Mechanical Engineering at the State University. Mr. Sibley will continue to direct the editorial work of the Journal.

Thomas Mirk, of Hunt, Mirk & Co., returned from San Diego to San Francisco last Monday after inspecting the work in progress for the San Diego Electric Railway Company. K. G. Dunn, electrical engineer with the firm, left on the same day for an extensive tour of the Pacific Northwest.

G. F. Chellis, an electrical engineer with J. G. White & Co., who is now at San Francisco, recently visited the San Joaquin power station in Crane Valley and supervised the starting of two new generating units. The San Joaquin Light and Power Corporation now has four units in operation at that point, with a total capacity of 20,000 h.p. They are ready to supply current for oil well drilling, irrigation, pumping, etc., in a large territory, through which their transmission lines are being extended. One of these lines will reach Los Banos, 125 miles north of the station.

J. Bumgarner is now superintendent of construction at the site of the Big Meadows dam of the Great Western Power Company. Preparations are being rushed for actual construction work. Good headway is being made on the installation of a special construction plant, which is to be entirely completed this fall. Two 350-kw., a.c. generators will be direct-connected to water wheels and will supply current for the operation of air compressors for drilling operations, electric cableway motors and concrete mixers.

ELECTRICAL CONTRACTORS' ASSOCIATION NOTES.

Seth Cohn of the Atlas Electric Company of San Mateo was in San Francisco this week.

Russ Wolden, president of the California Electrical Construction Company of San Francisco and San Jose, is enjoying a brief rest at Madrone Springs with his family.

W. S. Hanbridge has been elected secretary and treasurer of San Francisco District No. 1 of the California State Association of Electrical Contractors vice F. V. Meyers, who resigned in order to give his entire attention to his law practice. Mr. Meyers has been secretary for the contractors for a great many years and it was with keen regret that they accepted his resignation. As a token of their esteem Mr. Meyers was presented with a fine filing cabinet.

Noble Powell, director of Stockton District No. 8, was in San Francisco this week. Mr. Powell reports business rather poor in Stockton among the contractors on account of the electric company's method of wiring old houses free for five outlets and then charging for balance of work. The contractors fail to see why the power companies do not work in conjunction with the contractor, who pays a license, has an established place of business, carries a large stock, and is always called in except when something is being given away free.

John Rendles, president of the California State Association, has appointed the following committees, who will endeavor to bring about a more friendly feeling between the different branches of the electrical business, the intention being to make a careful study of the situation and endeavor to boost the others' game and have them boost ours:

Light and Power Committee—H. B. Woodill, Los Angeles; H. L. Miller, Pasadena; J. S. Reynolds, Santa Barbara; Phil Levy, San Francisco; C. V. Schneider, Sacramento; Seth Cohn, San Mateo.

Jobbers' Committee—"Chick" Ames, San Francisco; Frank Somers, San Jose; C. V. Schneider, Sacramento; G. E. Arbogast, Los Angeles; C. Loveday, Santa Barbara; C. L. Miller, Pasadena.

The directors for the coming year are: Q. R. Boynton, San Francisco; G. E. Arbogast, Los Angeles; C. V. Schneider, Sacramento; Carl Heilbron, San Diego; E. C. Wahelond, Oakland; A. P. Gaylord, Pasadena; J. S. Reynolds, Santa Barbara; Noble Powell, Stockton; Frank Somers, San Jose; Seth Cohn, San Mateo, Redwood and Palo Alto; Howard Ross, Riverside; O. Overhauser, Pomona; M. N. Phillips, Ventura.

In appointing his assistants for the year's work Mr. Rendles has selected a bunch of good hard workers and great things are promised for the coming year.

MEETING NOTICES.

A meeting of the Electrical Supply Jobbers' Association will be held at Portland, September 21, 22 and 23, 1911.

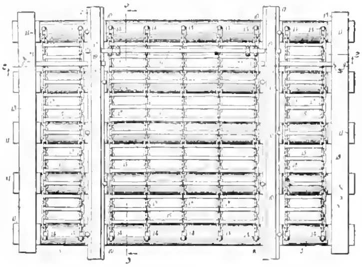
The Pacific Coast Gas Association will hold its nineteenth annual convention at Oakland, Cal., September 19, 20 and 21, 1911.

The Northwest Electric Light & Power Association will convene at Spokane, Wash., September 21, 22 and 23, 1911. A list of papers to be presented was published in this journal of July 22.

A meeting of those interested in technical advertising methods will be held at the Fly Trap restaurant, 73 Sutter street, San Francisco, August 21, during the noon hour. All publicity managers for machinery houses are cordially invited to attend this initial meeting which is planned to foster a closer co-operation between the technical press and its advertisers.

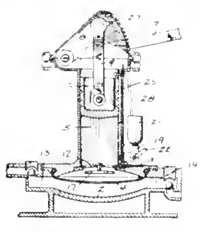
PATENTS

999,741. Railway Cattle-Guard Causeway. Samuel J. Billington and James A. Stephenson, Elliston, Mont. A railway cattle guard causeway, comprising a plurality of flexible members extended parallel with railway rails and fixedly secured at the ends of said causeway, said members permitting



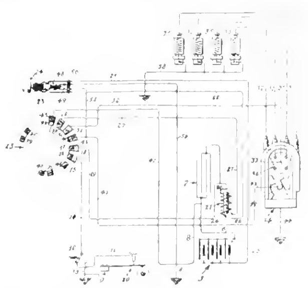
the flexure thereof to extend between the ties of said causeway; and rigid members extended between and connecting the said flexible members to form a latticework between the ends of said causeway.

999,832. Pump. Joseph Milburn, San Francisco, Cal. In a pump of the character described, a casing having its interior divided into two chambers by a diaphragm, a cylinder mounted on the casing, a spider provided with openings



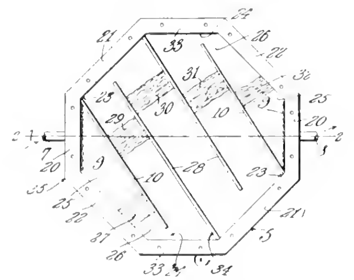
arranged between the cylinder and the casing, and a plate suspended from the spider adapted to be moved by the diaphragm to cover said openings.

999,894. Starting System for Gas-Engines. Harrison E. Slaughter, Los Angeles, Cal. A low tension starting system for explosion engines, comprising a low tension magneto, an electromagnetic spark plug, a battery, a step up coil for said bat-



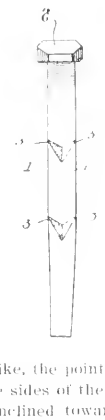
circuit passing through said spark plug and said magneto, an tery to produce an induced auxiliary current having a secondary winding connected with said spark plug, a magneto auxiliary battery circuit passing through said step up coil and said battery, a hand switch in said last circuit for opening said battery circuit to produce an induced current through said coil for actuating said spark plug, and a controller for controlling the circuits.

999,973. Gas-Purifier. John P. Farmer, Portland, Ore. assignor of one-fourth to Paul J. G. Kleppin and one-fourth to Joseph Wick, Portland, Ore. A gas purifier comprising a polygonal casing provided in its interior with spaced partitions extended in opposite directions, each partition being united with the casing in one of the interior angles of the casing and being extended into close relation to the interme-



diate portion of an opposite wall of the casing, whereby each of said walls will constitute a deflector to direct the gas into the angle formed by said wall and the next partition; there being a filtering material lodged between the partitions and in said angles; alined inlet and outlet pipes extended through opposite walls of the casing; each wall of the casing constituting a flat base upon which the casing may be successively supported, to permit the pipes to enter.

1,000,246. Railroad Spike. Emil Erikson, Emigrant Gap. A railroad spike provided with parallel sides, beveled front and rear faces and an overlapping head, the front and rear faces of the spike being provided with integrally formed pyramidal teeth, the said teeth being arranged in pairs upon the



opposite faces of the spike, the points of the teeth being positioned in a line with the sides of the spike, each of said teeth having its inner face inclined toward the face of the spike and its side or inner face beveled downwardly toward the central portion of the body of the spike to the point of juncture with the coacting teeth.

INDUSTRIAL

GAS-ELECTRIC CAR FOR SAN FRANCISCO RAILROAD.

The problem of producing a self-propelled car for railroad service, combining economical operation and luxurious comforts, has at last been solved.

The gas electric motor car with its reliability, low operating cost, flexibility of control combined with luxurious accommodations and freedom from cinders, smoke and coal gas, has found its place among railroads as a commercial success.

The six gas-electric motor cars which the St. Louis & San Francisco Railroad Company has purchased, are from the latest designs of the General Electric Company.

The cars are 70 ft. long and 10 ft. in width over the sills, with turtle back construction of roof, pointed front end and observation rear platform. The cars are designed with special reference to light construction with adequate strength. The interior arrangement is designed to meet the Southern traffic conditions, providing separate accommodations and entrances for white and colored passengers. The observation platform is unusually wide and is equipped with trap doors and brass railings, presenting a most attractive appearance. The windows are large, fitted with plate glass, and so arranged that they may be raised to a height of 17 in., allowing an unobstructed view. These are equipped with safety sash locks, anti-rattlers and weather strips. Each window is provided with a large fine mesh-copper, automatic screen running on metal guides. The window curtains are of pantasote of neat design and equipped with pinch handle fixtures.

The interior of the car is finished in a high grade of mahogany with paneling on the bulkheads. Each of the three compartments is provided with a saloon and drinking fountain. Electric fans are installed in each compartment.

The seats are of unusual length providing commodious accommodations for two persons and are amply large enough to seat three. These are of the stationary back type with high grade spring construction in both seat and back cushions, the former being provided with a spring edge adding greatly to the comfort of the passengers. The upholstering of the seats in all compartments is the latest in railroad practice, namely, Friezette plush. Ventilation is accomplished through large suction ventilators located on the center of the roof, the openings protected by neat ceiling register plates. The entire car, including platforms and vestibules, is lighted by electricity. The partition between the baggage room and negro compartment is movable and may be arranged to give the baggage compartment a length of 8 ft. or 10 ft. 5 in. to suit traffic requirements.

The framework of the car is entirely of steel, the under framing consisting of two I beams for center sills, and two channels for outside sills with truss rods for reinforcement. The center sills extend through to provide suitable supports for the rear platform. The outside sheathing is of sheet steel riveted to the posts with bats at the joints. The posts and carlines are of steel tees. The roof is of galvanized iron plates riveted to the carlines, except under the radiators where it is of copper with well soldered joints. The floors in the passenger compartments are of two thicknesses with a heavy layer of felt between. There is also an additional lining of sheet iron beneath the lower wood floor.

Basket racks of a continuous pattern are provided in all compartments.

The car is heated by hot water circulating in four lines of pipe on each side of the car.

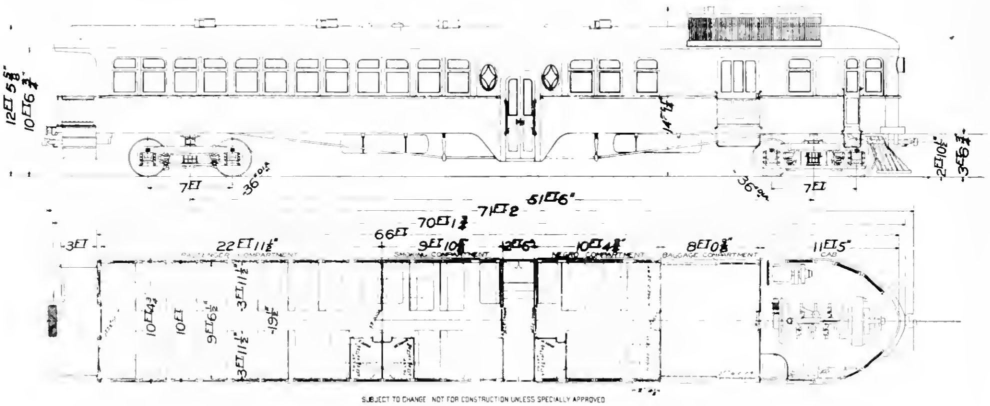


Fig. 1. New Type of Gas-Electric Car.

The front end of the car only is equipped with a pilot, inasmuch as the car is primarily for single end operation. Equipped and ready for operation, the car will weigh in the neighborhood of 48 tons.

A TELEPHONE PROTECTOR FOR OUTDOOR SERVICE.

A type of open space cutout in extensive use throughout the country today on telephone lines, both in railroad and commercial service, is the so-called No. 86 type protector, manufactured by the Western Electric Company.

This protector is made in two forms—one with a tin cover and the other with a cast-iron cover, known, respectively, as the Nos. 86-A and 86-B. These covers are chained firmly to the framework of the protector mounting, so that they cannot be lost through carelessness of the lineman.

The proctector itself is mounted on a porcelain base through the bottom of which the leading-in wires are brought in, and consists of heavy carbon blocks as shown in the illustration. The spacing between these blocks regulates the voltage at which the projector operates. Under normal conditions, this is adjusted to discharge at 1000 volts.

The shape of the carbon blocks gives a variable gap between the ground block and the two blocks connected to the line wire. The protectors are arranged so that carbon dust carried across by the discharge will not clog the spark

gap, but will automatically drop to the bottom of the protector.

The No. 86 type protector, as is noted, is designed for use both outside and indoors, and it is arranged so that it can be mounted directly on the pole itself. In some cases, it is desirable to have a protector which can be located in this manner outdoors, although as a general proposition, such a practice is not to be recommended on account of the additional maintenance difficulty thereby involved.

On telephone train dispatching lines, the No. 86 type protector is being used to a considerable extent throughout the country today, and it is giving very good satisfaction.

ANNUAL MEETING OF WESTINGHOUSE MFG. CO.

At a meeting of the board of directors of the Westinghouse Electric & Manufacturing Company, held in New York on August 1st, the following officers were elected:

Chairman of the board of directors, Robert Mather; president, Edwin M. Herr; vice-presidents, Loyall A. Osborne, Charles A. Terry, Harry P. Davis; acting vice-presidents, Henry D. Shute, George P. Hebard; comptroller and secretary, James C. Bennett; treasurer, T. W. Siemon; auditor, F. E. Craig.

Mr. E. M. Herr was elected to succeed Mr. Edwin F. Atkins, who has been president of the company since June, 1910, and who declined re-election.

Mr. Herr has been first vice-president of the company since 1905. He has announced the appointment of Calvert Townley as assistant to the president.

HEANY LAMP CASE.

About four years ago John Allan Heany, of York, Pa., and his patent attorney, and a young assistant examiner in the Patent Office, were indicted on charges of fraud and conspiracy in altering certain patent applications of Heany, then pending in the Patent Office, in an attempt to introduce into them inventions relating to tungsten incandescent lamps which had been made by others, information with respect to which, it was alleged, had been fraudulently obtained through the assistant examiner. On the trial the assistant examiner pleaded guilty and the attorney was tried and convicted, both being sentenced to imprisonment, and Heany was acquitted.

We now learn that on the termination of the criminal proceedings the Commissioner of Patents caused an investigation to be made with the object of ascertaining whether the fraudulent alterations in the applications were made with the knowledge or connivance of Heany. It was interrupted by a proceeding filed by Heany and the Heany Lamp Company, in the courts of the District of Columbia, in an attempt to enjoin the investigation. An injunction was issued by the lower court, but was set aside by the Court of Appeals, and investigation was then resumed. Testimony was taken and a full opportunity afforded to Heany and his associates to put in a defense. The decision of the Commissioner of Patents by Mr. Assistant Commissioner Billings, has now been handed down, holding that the applications of Heany pending in the Patent Office involved in the investigation had been tampered with and that among other things two sheets of paper on which the specification of one of the important cases was written had been abstracted and two other sheets substituted in place thereof; that this was done in pursuance of a conspiracy to fraudulently secure patents which would control the tungsten lamp business, and that Heany was a guilty party to the conspiracy. The Commissioner has ordered that certain pending interferences in which these applications under investigation were involved be dissolved as to the party Heany; that the Heany applications referred to be finally rejected on the ground of fraud, and that an endorsement to this effect be made on the applications and that they be removed from the files of the active cases of the office.

THE FARNSWORTH ELECTRICAL WORKS.

The Farnsworth Electrical Works have just completed the installation of an isolated plant with motor equipment for the San Francisco Salt Refining Company. The apparatus installed consists of the following: One 100-k.v.a., 2-phase, 220-v., G. E. alternator with exciter, 3-panel switchboard and Tirrell regulator, one 50-h.p. motor, two 30-h.p. vertical motors, two 30-h.p. standard motors, one 20-h.p. motor, two 15-h.p. motors, one 10-h.p. motor, one 5-h.p. motor, two 1½-h.p. motors, and complete wiring for motors and about 125 lights. The motors and generator were supplied by the General Electric Company. The switchboard is so arranged that any of the motor circuits can be connected to the service of the San Francisco Gas and Electric Company or to the generator. This firm also reports the recent sale and installation of a 75-h.p., 3-phase, 220-v. motor and a 5-h.p., 3-phase, 220-v. motor to the Petaluma Rock Company of Petaluma, Cal.

TRADE NOTES.

Munning-Loeb, Mattewan, N. J., manufacturers of electroplating and buffing apparatus and supplies, have appointed Otis & Squires of San Francisco as their Pacific Coast agents.

E. D. Hand, formerly with the Decker Electric Co., has been appointed Pacific Coast representative for the Brilliant Electric Co., the Atlantic Insulated Wire Co., the American Metals Works, the Enamel Metals Co., and S. H. Couch Co. He has established headquarters at room 310, Greenwood Bldg., 149 New Montgomery street, San Francisco.

The Fort Wayne Electric Works has been awarded a contract for an electric drill equipment from the Southern Consolidated Mining Company of Bodie. After a demonstration they found that the operation and economy were considerably in excess of the guarantees. A continuous run of forty days was made without a shut-down for repairs and less attendance was needed than for an air drill.

The Pelton Water Wheel Company has the contract for a 750-h.p. Pelton-Francis turbine, to be direct connected to its generator. It is to be operated under a 160 foot head at 400 r.p.m. and regulated by a Pelton oil-pressure governor. As a unique feature, a Pelton impulse wheel will eventually be mounted at the other end of the generator and operated under a head of 700 feet when there is a shortage in the main water supply.

F. B. DeGress, for over ten years New York district manager of the Crocker-Wheeler Company, has resigned from that company to assume the position of general sales manager of the Pulsometer Company, 17 Battery Place, New York City. Besides looking after the sales end of the business, Mr. DeGress is also carrying on a series of experiments, with a view to improving certain features of the pulsometer in order to make it suitable for general pumping work in power plants, industrial establishments, etc., so that it may become as popular for this class of work as it is in the general contracting field where it is now so well known.

H. M. Byllesby & Company, engineers and managers of public utilities, through their principal office at Chicago, confirm the reported purchase of the Sioux Falls Light & Power Company of Sioux Falls, South Dakota. This company owns and operates a water power generating plant on the Big Sioux River, reinforced by a modern steam auxiliary station, and serves the greater part of Sioux Falls with current for lighting, transportation and power. Formal possession will be taken in a few days with N. C. Draper, formerly of Zanesville, Ohio, as manager. Improvements and extensions will be made to the property.

NEWS NOTES

FINANCIAL.

OAKDALE, CAL. Sealed bids were received until August 7th for the purchase of $25,000 water bonds and $20,000 sewer bonds.

SALMON CITY, IDAHO.—The Lemhi Power Company, C. L. Mackenzie, president, has taken over the holdings of the Andrews Light & Power Company, for a consideration of $76,000.

LOS ANGELES, CAL.—Mayor Alexander urges that the council authorize a bond sale of $3,250,000 at once. He states that the harbor will require $1,250,000 and the power enterprise at least $2,000,000.

SEATTLE, WASH.—J. C. Corbin & Co., American Bank building, Seattle, has been formally awarded the contract for constructing a new power plant at the Veterans' Home, at this place, at $13,987.

HONOLULU, H. T.—The Kehena Water Company has been incorporated with $10,000 capital, which may be increased to $1,000,000, to develop an irrigation system from the East Honokane waters of Kohala.

ASTORIA, ORE.—Bids were received by G. Lounsberry, clerk of the Water Commissioners, at the commissioners' office in the city hall, Astoria, Ore., until August 11th, for the purchase of $45,000 of City Water Commission bonds, to run 20 years, from date of payment, to bear interest at 5 per cent per annum, payable semi-annually.

MEXICO CITY, MEX.—The Electric Tramways Company of Mexico City has determined to spend a sum of $500,000 on the construction of new electric lines. Among the work undertaken is the completion of the Atzcapotzalco to Tlalnepantla line, the building of the Peralvillo to Valbuena line, and the electrification of the few lines of horse traction still existing in Mexico.

BAKER CITY, ORE.—Hainland Bros. have completed the capitalization for the $4,000,000 Ox Bow project. A million and a half have been already spent in tunneling through the Ox Bow curve. Two million and a half will be required to complete the project. A dam 1040 feet in length and 56 feet in height will be constructed and a power plant, the foundations of which have already been placed, will be built.

SPOKANE, WASH.—The International Power & Manufacturing Company, capital $250,000, has been incorporated by Wilbur S. Yearseley, Martin H. Gerry, Jr. The company is a subsidiary corporation of the organization developing Millwood, a manufacturing suburb, three miles east of this place. The company also intends to construct a dam across the river and erect a power plant for the operation of the Inland Empire paper mill.

INCORPORATIONS.

WALNUT CREEK, CAL.—The Walnut Creek Water Company has been incorporated for $200,000 by H. H. Scott, W. C. Burgess, F. B. Bradley, P. A. Thompson and J. W. Meyer.

GLENDORA, CAL.—The Glendora Independent Water Company has been organized with a capital stock of $200,000. The company has installed a new system of pumps at the wells.

SALINAS, CAL.—The California Consolidated Light & Power Company, Salinas, has been incorporated for $5,000,000, by C. S. Chaunsey, S. Goodrich, J. T. Pigott, T. E. Palmer, Grover O'Connor and G. R. Ray.

HOOD RIVER, ORE.—Articles of incorporation have been filed at Salem by the Hood River Terminal Company of Portland, the incorporators being W. A. Delashmutt, A. B., Ireland and W. Chapman; capital stock $5000.

RIVERSIDE, CAL.—The Cajalco Water Company has been incorporated with a capital stock of $10,000, of which $20 has been subscribed. The directors are A. R. Dickson and George Mabey, of Corona and Arthur S. Holden, F. D. Hudson and W. G. Farndale, all of Riverside.

ELKO, NEV.—The new camp of Jarbridge is to have electric light and power, the latter for the operation of mines and mills. The Jarbridge Power Company, with a capitalization of $100,000 has been formed and articles of incorporation have been filed. The incorporators are all Jarbridge people, Gilmore Kenney Jr., J. M. Kinney, J. T. Brunn and George F. Elliott.

ILLUMINATION.

BAKER CITY, ORE.—There is no prospect of the city lighting plant for which $25,000 bonds have been voted, being built this year.

PALMS, CAL.—The Board of Supervisors has issued a proclamation for an election on August 10 to determine whether or not a highway lighting system shall be formed in Palms.

PERRIS, CAL. N. L. Graham of Riverside, representing F. A. Worthley, has applied for a 50-year franchise to operate an electric light and power system over streets and alleys of the city.

GRANDVIEW, WASH.—The Council has passed an ordinance granting to the Pacific Power & Light Company the right to construct electric light and power lines in the city of Grandview.

SEATTLE, WASH.—Bids were received by the State Board of Control, Olympia, until August 7th, for the complete power plant equipment at the Washington Veterans' Home, Fort Orchard.

LA MESA, CAL.—The San Diego Consolidated Gas & Electric Company has offered to extend its gas mains east from City Heights to La Mesa, provided 150 people in the vicinity agree to use it.

ELLENSBURG, WASH.—The City Council passed an ordinance revoking a gas franchise granted A. Wright and also gave first reading to the franchise submitted by Dr. J. T. Harvey of Ellensburg, granting him the right to manufacture gas for illuminating, heating and other purposes within the limits of the city.

COLTON, CAL.—A large central plant to be erected by the Southern California Gas Company is the latest industrial acquisition for Colton. Everything about the plant is to be on a big scale as the purchase of six acres of land and the expectation of investing $75,000 in the building and equipments attest. The company has bought with the intention of locating a great central plant for the manufacture and distribution of gas to this city, San Bernardino, Redlands, Riverside and other cities and towns of the valley.

TRANSMISSION.

BLAINE, WASH.—It is reported that the British Columbia Electric Railway Company will extend its power transmission line to this place.

LEWISTON, IDAHO.—It is understood that the Pacific Light & Power Company is perfecting plans to extend its electric line from Walla Walla to Clarkston.

BOISE CITY, IDAHO Attorney Jesse P. Hawley, representing the Beaver River Power Company, has applied to the City Council for a franchise to operate in Boise.

BREMERTON, WASH.—The Bremerton-Charleston Light & Fuel Company, has applied to the Board of County Commissioners of Kitsap County, Wash., for the right to establish and maintain a line of electric poles and wires over and along the county roads of Bremerton.

EUGENE, ORE.—It is reported that Wilhelm & Sons will at once construct a concrete dam spanning the Long Tom river at this place. The dam will be 150 feet in length, 12 feet high and of sufficient strength to withstand the impact of strong waters. The structure will create additional water power for the operation of a flour mill.

RIVERSIDE, CAL.—Additional facts of importance concerning the power proposition which has been represented by F. A. Worthley of this city, have come to light. The company, which has secured franchises for pole lines in San Bernardino and Riverside Counties and has applied for same in the city of San Bernardino, is the Southern Sierras Power Company, financed by Denver capitalists. Delos A. Chappel is the vice-president and general manager and will probably have his headquarters in Riverside. The contract has been let for a steam plant at San Bernardino, or in the immediate vicinity of that city. This will have an initial capacity of 5000 kw. Contracts have also been let for poles and wire, and the installation of the transmission lines will be pushed with all possible speed. Distributing lines will be run to Moreno and Perris, and to Corona by way of West Riverside. The delivery of power to these sections will mean the development of thousands of acres of fruit and alfalfa lands that heretofore have lain dormant. An office has been opened in the First National Bank building in this city, and offices will be established in the surrounding towns.

TRANSPORTATION.

SAN DIEGO, CAL.—The bid of the San Diego Electric Railway Company of $60,000 for a 42-year franchise over all its lines in the city has been accepted by unanimous vote of the Council.

SANTA MONICA, CAL.—The City Council has granted the Pacific Electric Company permission to extend its Eighth street line from Fremont to Garfield avenue and the city clerk has been instructed to advertise for bids for the franchise.

SAN JOSE, CAL.—The San Jose railroads have made application to the Board of Supervisors for a franchise for a single or double track standard gauge electric railroad along Willow steet, Delmas avenue and Lincoln avenue, for a period of 50 years.

PORTLAND, ORE.—Plans for a terminal station have been filed with Building Inspector Plummer by the Mount Hood Railway & Power Company. The location is near the O. W. P & N. tracks, between Vancouver and Williams avenue; cost $45,000.

LOS ANGELES, CAL.—The Los Angeles Railway Corporation will let the contract for the new car barn to cost $150,000 and it will cover five and a half acres. Plans have been prepared by Chief Engineer George Kurts. There will be a fireproof concrete and steel building at Fifty-fourth and Arlington streets. Twenty-four tracks will be laid inside. An employes building of concrete and steel, measuring 100 by 100 feet, will also be built, which will contain bathrooms, billiard rooms, library and assembly room.

LOS ANGELES, CAL.—H. T. Hazzard has petitioned the council to allow the Los Angeles Railway Co. to run a spur track on West Fourth street, between Berendo and North Kenmore avenues, so that cars may be run around the proposed fill to be made there.

RED BLUFF, CAL. The fund raised in the four counties of Yolo, Glenn, Colusa, and Tehama for the purpose of securing money necessary to make a preliminary survey and secure rights of way for an electric railroad from Woodland to Red Bluff, has now been completed.

SEBASTOPOL, CAL.—The Board of Trustees has passed an ordinance granting permission to the Petaluma and Santa Rosa Railway Company, for a period of 50 years, to construct a line of a standard gauge railroad, to be operated by electricity in public highways within the town of Sebastopol.

SAN JOSE, CAL.—The San Jose and Santa Clara County Railroad Company has made application to the Board of Supervisors for a franchise for a standard gauge electric railroad over the highway known as the Alameda, for a period of 30 years. Also for a franchise over Fourteenth street.

RICHMOND, CAL.—A plan proposed by John Nicholl and the Los Angeles Pressed Brick Company is the building of a street railway from Richmond avenue along Marine drive, which skirts Nicholl knob, around the point and thence down to the plant of the brick company, located on the bay shore southeast of the mole of the Santa Fe at Ferry Point.

SAN JOSE, CAL.—The supervisors have ordered a franchise over Saratoga avenue from Meridian corners to the limits of the town of Santa Clara, advertised for sale. It is the intention of the Peninsula railway to buy up the franchise in order that it may connect the interurban line with the lines running out Alameda to Santa Clara, thus forming a loop on which to operate its cars. The franchises of the San Jose and Santa Clara Railroad Company on the Alameda and North Fourteenth streets and that of the San Jose Railroad Company's Delmas and Willow streets line, which have expired, were also advertised for sale. Bids for these franchises will be opened on September 5, at 11 a. m.

TELEPHONE AND TELEGRAPH.

ENTERPRISE, ORE.—Carl Roe is at the head of a project to establish a telephone system here.

PETALUMA, CAL.—The Petaluma Rural Telephone Company has decided to build a rural line from Petaluma to Cotati.

KALAMA, WASH.—The county commissioners have granted franchises to the Cowlitz Bend Telephone Company for the construction of telephone lines.

COLUSA, CAL.—The Tehama County Telephone Company will be ready for business in a few days. The new company contemplates extensive improvements in all parts of the county.

SEATTLE, WASH.—The public service commission's figures as to the value of the two local telephone systems, is as follows: The Bell or Sunset telephone system, valued at $3,100,000, and the value of the Independent telephone system's property in Seattle at $1,500,000.

WATERWORKS.

SALEM, ORE. The State Fair Board has appropriated $10,000 for the enlarging of water mains, and extending the same in the fair grounds.

PROSSER, WASH.—The City engineer has been instructed to prepare plans for the construction of a distributing system to furnish the city water from the government irrigation ditch.

MEDFORD, ORE.—Bids were received by the city council, up to August 15th, for the purchase of $4000 in bonds for the installation of water mains.

PRESTON, IDAHO.—This place will soon call a bond election to cover $90,000 for a village water system. J. N. Preston, chairman, village board.

BRIDGEPORT, CAL.—Sealed bids have been received by the Board of Supervisors for the erection and installation of a complete water system for use of the county court house at Bridgeport.

MADRAS, ORE.—A petition asking that W. P. Myers and O. C. Young be granted a franchise for the establishment of a water system for the town of Culver has been granted by the council.

GOLDENDALE, WASH.—The Valley of Glenwood is to be irrigated with water from Hell Roaring Creek. This valley is located 30 miles north and west of Goldendale on a tributary of the Big Klickitat.

LONG BEACH, CAL.—The local Board of Water Commissioners will employ a consulting engineer to draft plans and specifications for improvements and extension of the city water plants on a large scale.

CONNELL, WASH.—A franchise for laying the water mains in the town of Eltopia has been granted by the council to A. R. Hamilton for 25 years. The same franchise was also granted and for the same term to C. G. Fuller.

AUBURN, CAL.—The residents of Prospect Hill, in the western portion of the city, are having a water famine. If conditions do not improve, the people intend to put in a pumping plant, getting their supply from the Kelley well.

OLYMPIA, WASH.—Owing to the lateness of the season the State Board of Control has decided not to continue asking bids on pumping equipment for the State penitentiary at Walla Walla. Bids for this machinery were to be opened on August 14.

RED BLUFF, CAL.—Norman R. Smith, the patentee of the water pumping plant soon to be installed here, is in Red Bluff from Grants Pass, Ore. Mr. Cunningham has put one of these plants in the river at Anderson and in time will install one in the river at this place.

WOODBURN, Ore.—A special election will be held in the forepart of September to decide on a bond issue of about $25,000 for acquiring the present water plant, now owned by an independent company. If bonds are authorized extensions will be made.

NORTH BEND, ORE.—At a meeting of the commission from the North Bend council with the members of the council of Marshfield it was decided to employ an engineer to obtain the probable cost of building a new water system and also the cost of improving the present system which it is proposed to take over from the Flanagan & Bonnett Water Company.

NANAIMO, B. C.—City Engineer Waters reported the following estimate on the installation of an additional water main; approximately $10,000 for 18-inch wood stave pipe, $18,200 for an 18-inch steel welded pipe and the sum of $21,100 for an 18-inch cast iron pipe. This place is decidedly in favor of installing the additional main and an election for authorization of bonds is probable.

WALNUT CREEK, CAL.—A new water plant has been built in this place by the R. N. Burgess Company and was placed in operation on August 10. A power line is now being erected by the Pacific Gas & Electric Company to the artesian wells and reservoirs of the system, which are about one mile from town. The new plant will serve water in competition to the present plant in operation.

LOS ANGELES, CAL.—The Kern Meadows Land & Water Company, handling a tract of 10,000 acres in Kern county, plans to develop the land by completing a perfect ditch system and drilling sufficient number of additional wells to give ample supply to water users. H. E. Carse, consulting engineer who will have charge of water development and is general manager of the company has his main office at 222 Security Building.

ASTORIA, ORE.—The water commission has considered the plans and specifications submitted by Engineer Lars Berosvik for the construction of a dam at the head works and a storage reservoir with a capacity of 100,000,000 gallons. The plans have been accepted by the commission and the construction ordered advertised at once. The work is to be completed October 1, 1912. Bids were received up to August 14th. The dam will be 25 feet long on the bottom, 160 feet long on top, 54 feet in width at the bottom, 111½ feet wide at the top and 74 feet high, and will cover an area of 22 acres.

NEW CATALOGUES.

James Beggs & Co. of New York have recently completed their attractive new catalog on the Blackburn-Smith Pressure Filter.

The Bates Machine Co. of Joliet, Ill., has issued a new catalog on the Cookson castiron heaters and receivers with cut-out valves.

The Western Electric Company have recently published Bulleten No. 1105 on Inter-phone systems, filled with interesting illustrations.

The Gould Storage Battery Company have just published an attractive Bulletin No. 12 on the storage battery installation in the Detroit river tunnel plant.

The Triumph Electric Co. of Cincinnati, Ohio, have just issued Bulletin No. 481, on alternating generators of the direct connected type. It is well illustrated and instructive.

The Kerr Turbine Company of Wellsville, N. Y., have issued an artistically illustrated catalog on the Kerr steam turbine for driving generators, centrifugal pumps, fans and other high speed machinery, and for belt drive.

The National Tube Co. of Pittsburgh, has just issued Catalogue H, embracing wrought pipe for steam, gas, water and air. Cast, malleable iron and brass fittings. Brass and iron body valves and cocks. Radiators and coils. Drive well points and well supplies.

The Electrical Engineer's Equipment Co., of Chicago, announce through their Pacific Coast agents, J. C. Farrar & Co. of Los Angeles, the issuance of their new catalogue on electrical fittings for power plants. The publication is profusely illustrated and contains much valuable information in addition to listing of its standard fittings.

Catalogue No. 15, from the H. W. Johns-Manville Co., contains over 400 pages of illustrations and descriptions of their various electrical specialties. These include materials for insulating, for overhead line construction, mine and third rail work, as well as the Linolite system of illumination and underground fibre conduit.

The Kellogg Switchboard & Supply Co. has recently issued a new apparatus bulletin. It is altogether a new and unique catalogue in the Independent Telephone industry, in that it covers all the important items in standard telephone work. Each item is illustrated, coded and given a brief description. Since sending out this catalogue, we have received many favorable comments from our customers and the trade generally. A telephone man wishing to buy anything from binding posts to pole changers, or dry cells to a twenty thousand line exchange, can find the important specifications in this catalogue in a minute's notice by referring to a comprehensive index.

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ISOLATED VERSUS CENTRAL STATION PLANTS

Much interest attaches to the live question of central station service as opposed to isolated plant service. Similar to many other fine points in engineering practice, local conditions must be the deciding factor in each particular case. At times there arise questions of stability of service, cost of maintenance and operation of such a nature as to make it good judgment to close down the operating department of the isolated plant in favor of the central station supply, even though the very best and latest type of installation has been made in the smaller plant. On the other hand, many instances can be cited where the isolated plant has proved the unquestioned superior, and still others where a combination of the two prove the more economical, such, for instance, as the installation at the University of California. Here the central station is called upon to assist in carrying the peak load and other portions of the daily load which prove uneconomical or too cumbersome for the local installation. A recent instance of a case in which the central station has won out over the isolated plant system is that of the U. S. Mint at Denver, Colo. We are indebted to R. B. Mateer of the Denver Gas & Electric Company, for the data furnished regarding this installation.

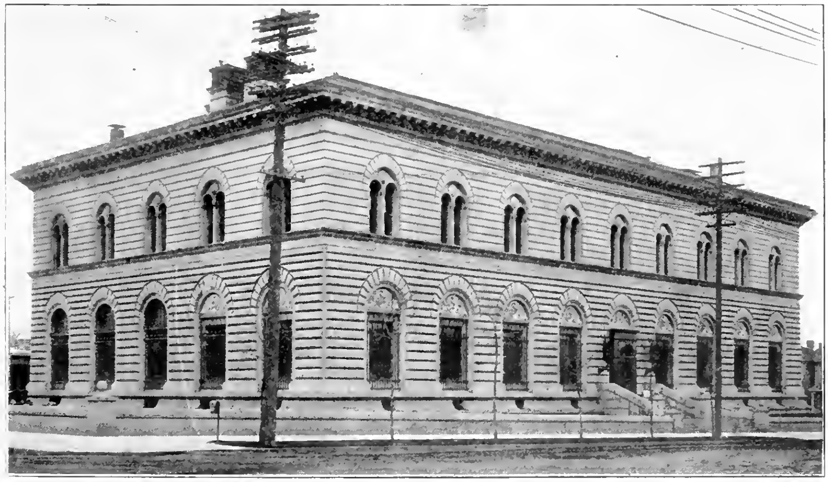


Fig 1. U. S. Mint at Denver, Where Central Station Has Proved Superior to Isolated Plant Service.

Government buildings possess a distinctive style of architecture and are universally admired for the simplicity and beauty of the exteriors. As a rule they are a class of buildings so equipped as to be independent of all quasi public utility corporations. For instance in some are found an artesian well to provide the water; an elaborate, yet very efficient steam and electric generating plant to supply all necessary heat, the power desired for the operation of machinery and the production of artificial light, which go to make a very complete and isolated class of buildings.

The Mints, that provide the gold, silver and copper mediums of exchange, are equipped with the finest engines, generators, motors and auxiliary machinery that can be manufactured. The equipment must possess certain requirements superior to those exacted by the average industry. A different rating, certain

length of tests, certain quality of materials are required of such apparatus as is sold for governmental buildings. The motor must be adapted for that particular class.
of machine. Nowhere can be found apparatus possessing so many good points as in the Mints located at various centers of industry and population. Good judgment and experience have resulted in an isolated plant of the latest and most efficient type at the Mint at Denver, Colorado.

The machine in each department is direct connected to its individual motor. The huge rolls are operated with 50 h.p. Crocker-Wheeler motors; the coining machines with Westinghouse and Crocker-Wheeler 7½ h.p. motors. A complete machine shop with each lathe, drill, grinder, planer, saw and milling machine direct connected to a motor, is located in one section of the building, while in another is found an individual motor-driven installation of woodworking machinery, including a jigsaw, planer, circular saw, mortising machine, lathe, molding machine, sand paper machine and emery wheel.

Otis elevators and lifts render access to each portion of the building easy and economize in time as well as physical energy.

Motor operated reviewing and weighing machines assure perfect coins for the use of the public.

Exhaust fans, properly installed, preserve the health of those employed at the building and rapidly discharge to the outer air injurious acid fumes.

Gas and oil furnaces are used in the assaying departments. To supply the necessary air to produce the proper combustion, Connerville blowers are installed in the basement of the building and are operated by 20, 15 and 5 h.p. motors of Westinghouse, Bullock and General Electric product.

A feature of the basement, is an Ellspass Mill, used in concentrating. A 15 h.p. Fairbanks Morse motor operates this machine while 2 h.p. General Electric motor drives the centrifugal pump.

The compressors for the deep wells and house pumps are in duplicate,—accident to one permits of an abundant supply from the remaining one. The compressors are each operated by a 20 h.p. Commercial Electric motor and the house pumps are direct connected to 3½ h.p. Commercial motors.

A special motor, for each machine, varying from 50 h.p. on the rolls to the ½ h.p. motors that operate the ringing sets of the telephone exchange makes a total connected motor load of 708½ h.p., 220 volt direct current.

Ample lighting is provided by 1500 lamps of from 60 to 100 watt tungsten filaments.

The building is complete with every mechanical labor saving device. It contains an engine room equipped with the most efficient machinery money could purchase or human intelligence design, yet isolated completely so far as water, heat, light and power necessities, were concerned.

In June of this year arrangements were completed whereby the isolated plant was discontinued. Central Station service supplied by the Denver Gas & Electric Light Company replaced the isolated plant that had been installed several years ago; 250-500 volt three-wire direct current is now supplied for the operation of the entire 708½ h.p. motor load; 110-220 volt three-wire single-phase alternating service supplies the artificial light.

"Good service at all times" such as is rendered by the Denver Gas & Electric Light Company, has brought about perfect satisfaction and this combined with the resultant economy is an excellent proof of the value and superiority of the central station service.

All negotiations for this business were conducted by the power department of the Denver Gas & Electric Light Company, which has secured for the central station service a revenue producer and augmented the connected load, far in excess of earlier expectations.

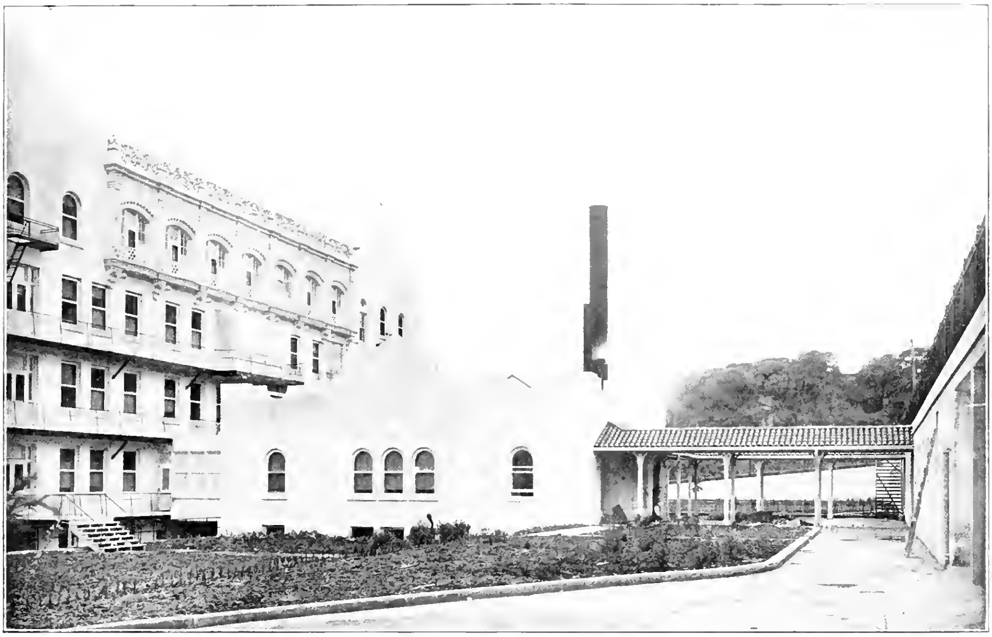
When originally constructed the St. Francis Hotel of San Francisco was provided with a power equipment suitable for all service other than furnishing the electrical energy required. In the spring of 1909, the management considered the installation of its own electric plant and after careful investigation the advantages to be derived therefrom secured its adoption. The plant as completed has a total capacity of 825 kw. The St. Francis hotel is the largest and perhaps the most completely equipped hostelry in San Francisco and its appointments are such as to promote the comfort and freedom of its guests. Its entire electrical equipment is in full harmony with the general make-up of the building and has had its proportionate care and thoroughness in design. Recently, however, the management, after careful reconsideration of every detail, have decided to close down the operation of the plant and purchase power from the Pacific Gas & Electric Company.

On the other hand, an excellent illustration of the isolated power plant and its ease and continuity of operation is that of St. Mary's Hospital in San Francisco. The field of operation for an isolated power plant included in the equipment of quasi-public buildings is nowhere better exemplified that for use in the modern hospital. Here electricity is put to scores of uses and the auxiliary features of the plant, i. e., the distribution and circulation of steam, hot and cold water, compressed air or vacuum, together, make almost every condition of operation and action except of course, the human element, dependent upon the power plant.

The equipment of St. Mary's hospital in San Francisco is perhaps as complete and thorough as modern science can dictate; the arrangement, unlike many isolated equipments having been worked out to accomplish the best results in efficiency, ample space, light, air and general accessibility.

The power plant occupies the ground floor, which is in reality a basement, as it is a few feet below the ground surface. There are at present two main generating sets, which are duplicates. The engines are Brownell high speed, non-condensing. They are fitted with Rites inertia governors and direct connected to General Electric six-pole, 75 kw., 250 volt direct current generators, operating at 275 r.p.m.

Among the many high class features of this installation is to be mentioned the comprehensive system of signal lights and calls from all rooms. Instead of the familiar bells or buzzers, which are often annoying to nervous patients, there is on each floor

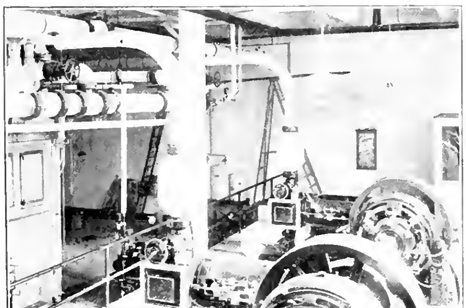


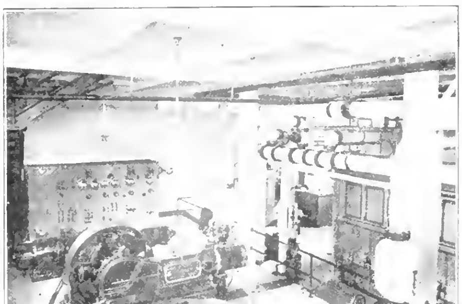
Typical Isolated Power Plant, St. Mary's Hospital, San Francisco.

a Westminster chime of four tones. These chimes consist of bell-metal tubes which are sounded by an electrically operated hammer. The different pitches of tone denote nurses or attendants of different grades of authority, while the number of strokes signify the individual wanted.

Another novelty is an arrangement for electrically heating the tray carriers. These carriers are of sheet metal in the form of a large box in which are fitted shelves, the whole, being mounted on rubber-tired wheels. Within is a heating coil which enables food in trays to be kept warm while the carrier is being filled and during its journey to the various wards. At a convenient place near the kitchen, there are several wall plug receptacles supplying the current to heat the tray carriers and a set of baby knife switches provided directly under them control the current.

No less striking in its accomplishment of continuity of service is that of the isolated power plant in the Alaska Commercial Building. As a safeguard against any possible break in the service there have been installed storage batteries of sufficient capacity to tide over any reasonable period due to a breakdown of any part of the installation.





General View of Engine and Boiler Room and View of Generating Units from Switchboard, St. Mary's Hospital.

The original installation in the Alaska Commercial Building in San Francisco, Cal., consisted of two 100 kw. and one 75 kw. Westinghouse three-wire generators, each direct connected to Skinner simple engines. The line voltage was 120-0-120. The electric elevator and motor service was operated from the 240 volt circuit.

The use of the electric elevators in this large office building caused extremely violent and rapid fluctuations in the load, the fluctuations, under average conditions, being from 20 to 250 kw. and occasionally as high as 400 kw. These fluctuations were so rapid that the voltage regulation was extremely erratic, as the engines were not driven sufficient time to compensate for the changes in load.

This plant, besides supplying electricity and steam to the Alaska Commercial Building, also sells power to neighboring office buildings, for lights, elevators, etc., and had an average monthly load in the neighborhood of 20,000 kw. hours. The plant was operated originally from 7 o'clock in the morning until 11 o'clock at night, power for the remaining 8 hours of the day being obtained from the city service.

The effects of the fluctuations in load follow:

1st—It was necessary to have operating, sufficient capacity for the maximum load at all times or otherwise frequent interruptions in service ensued.


Another Excellent Illustration of Isolated Power Plant. Storage Batteries for Alaska Commercial Building.

2d—Due to the low power factor, the efficiency was very low and the only consumption per kw. hour very high.

3d—The voltage regulation under these conditions was poor, and was a source of numerous complaints.

4th—The "racking" of the engines caused by the violent fluctuations in the load was rapidly deteriorating and the same would shortly have made repairs necessary.

On account of these conditions, the engineer of the Alaska Commercial Building, Mr. John Williams, decided that a storage battery installed would relieve the same and after thoroughly investigating the subject awarded the contract to the Gould Storage Battery Company.

The storage battery installation consists of 116 cells type 0-511, having a capacity of 200 amperes for one hour at approximately 240 volts, together with a "Gould" C. E. M. F. regulating booster, three-unit set, having a maximum capacity of 600 amperes at [illegible] volts. The operation of this storage battery installation resulted in the following improvements in service:

1st—The fluctuations in load were equalized by the battery, the battery discharging when the load demand was heavy and charging when the heavy load fell off, thereby maintaining practically a constant load on the generators. This load is maintained constant within 5 per cent plus or minus; that is to say, if the regulation is set for 200 amperes, the maximum fluctuations in load on the generators would be between 190 and 210 amperes.

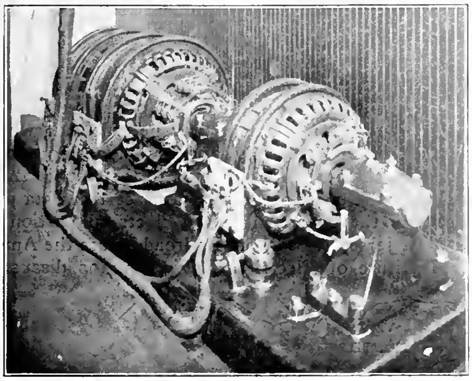
2d—Due to the load on the generators being maintained constant, it was found that the 75 kw. unit would carry the load during the greater part of the day, one of the larger units being necessary for lighting purposes, during winter only, for a few hours each day.

3d—As only one generator was required to be used and as the load was kept practically constant on this at the point of maximum efficiency, the oil consumption per kw. hour was very much reduced.

4th—On account of the ideal conditions under which the generators operated, the voltage regulation was absolutely perfect and no further complaints possible.

5th—The entire plant is shut down each night be-

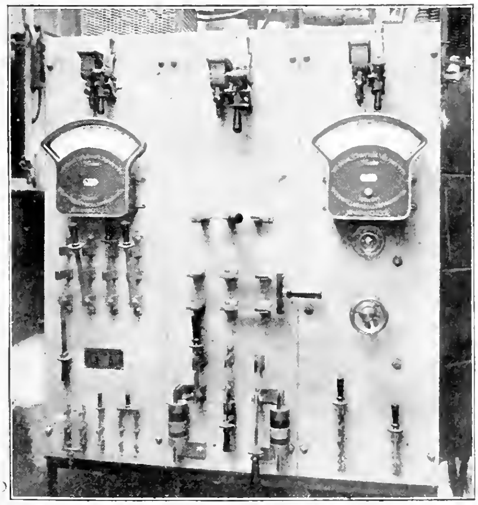
tween 10 p. m. and 7 a. m., the storage battery supplying the electricity necessary for the night run. In this way the cost of the electric service from the city supply was entirely eliminated.



Power Equipment Alaska Commercial Building.

6th—As the battery is discharged during the night and has to be charged the first thing in the morning, this gives a heavy load on the machine in the morning and furnishes abundance of exhaust steam for heating at the time it is most needed.

7th—After the heavy load goes off at about 6 o'clock in the evening, the completion of the charge of the battery to carry the night load supplies a full load to the generators until time to shut down, thus maintaining the high efficiency of the plant.



Switchboard Equipment, Alaska Commercial Building.

8th—In case of accident to the generator plant the battery will carry the entire load for about three quarters of an hour, giving ample time to put another generator set or boiler in service.

9th—Operating the plant by one generator unit alone, which the storage battery installation made possible, gives two units in reserve and makes shut downs of any duration impossible.

10th—By operating the generators under practically constant load, the shock of the fluctuations is removed and repairs reduced to a minimum.

11th—One of the greatest advantages of the installations is that due to the steady load on the entire plant it is possible to study the operating conditions of each part of the system under steady full load conditions and thus work out the maximum efficiency possible by tuning up the whole plant.

12th—Due to the improvements in efficiency and economy above set forth, a considerable saving in cash is effected each month and it is estimated that this saving will pay for the battery installation in three years' time.

This plant has now been in operation over a year and has satisfactorily met all the conditions imposed upon it. On one occasion it carried the load of the building, due to an accident in the engine for fifteen minutes while another generator was put in service.

MEDALS FOR CONDUCTORS.

The management of the Chicago & Milwaukee Electric Railroad, has decided to award a gold medal each month to the most efficient conductor in their service. E. H. Igou has received the first medal. The following high ideals of Mr. Igou were undoubtedly largely responsible for his attaining the distinction of being awarded the first decision:

"Passengers are patrons of your employer. Treat them as such. Help old women and women with babies or bundles on and off the car. Remember, where your regular passengers get off and don't haul them by. If old women or women with babies have no seat, ask some man to give them a seat. In rainy days open umbrellas for women as they get off. It saves accidents. Never give curt answers. If you're busy, wait to answer until you're through. Be as polite to homely women as to pretty women. Wait for passengers who are trying to catch the car. Keep your car clean and your patrons will help you."

TRAIN DISPATCHING BY TELEPHONE IN BRITISH COLUMBIA.

Of possible interest to American manufacturers of telephones is the report just published, quoting the superintendent of the Grand Trunk Railway telegraphs, W. W. Ashall, of Montreal, as stating that his company is about to adopt the telephone in place of the telegraph for train dispatching over its entire system, which is already extensive in British Columbia and is being rapidly added to in this Province, the main line to Prince Rupert being now under construction.

PHILIPPINE FRANCHISE AT PUBLIC AUCTION.

In regard to the disposition of the gas franchise for the city of Manila recently awarded the Bremen syndicate and forfeited by it on account of nonfulfillment of terms of the franchise, the Governor General has stated that the franchise will be put up at public auction if there are persons desiring to present bids.

QUICK CHECKS FOR ENGINEERING COMPUTATIONS.

It is a matter of considerable importance in making computations to know that we have done the same correctly. Very often engineers are called upon to make hasty calculations in a rather unfamiliar field and consequently errors creep in when attempting to substitute in various formulas. An error is very likely to occur in ordinary multiplication. A very simple rule to quickly test the accuracy is to sum up the digits in each number, and cast out the "nines" or multiples of nine appearing in each sum. Next multiply the remainders and again cast out the "nines" or multiples of nine. Now if you sum up the digits in your result you have found from multiplying your two original numbers and similarly cast out nines or multiples of nine, your two remainders should be identical, otherwise some mistake has been made.

Let us suppose for instance we desire to multiply 938 by 746. This operation is performed as follows:

938	(a) 20 or 2
746	(b) 17 or 8 (c) 16 or 7
5628	(e) 12 or 3
3752	(f) 8
6566	(g) 5
699,748	(d) 43 or 7

According to our rule set forth above, we find the sum of the digits in a to be 20, or casting out nines we have 2. The sum of the digits in b is 17, or casting out nines we have 8. Now multiplying this result in a and b together we have the result shown at c, which is 16, or casting out nines 7. Again adding the digits in d we have 43 and casting out nines obtain the result of 7. Since this is the same as appears at c our multiplication is evidently correct. Suppose these results are not the same and we desire to check each individual multiplication. By performing each individual casting out of nines in e, f and g this result in turn should correspond with 6 multiplied by a, 4 multiplied by a and 7 multiplied by a, or 3, 8 and 5 respectively. If the reader has never used this method, he can hardly realize how serviceable and quick this result is. By all means master it at once.

HONGKONG OIL IMPORTS.

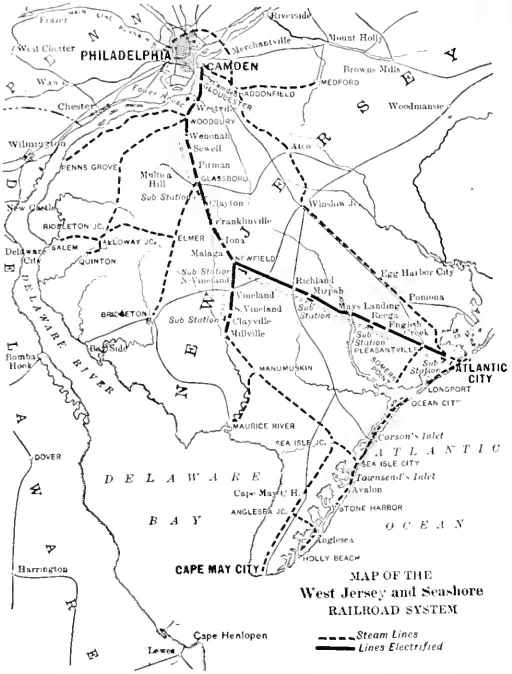
Dominant American oil interests have announced their intention of increasing the world's consumption of oil by lowering the prices. This announcement had the effect of increasing the sale of the American product in the Far East. The imports of oil into Hongkong and the several tributary ports and territories—Canton, Amoy, Swatow, Foochow, Haifong, Saigon, Bangkok, and Philippine Islands—in 1910 were 89,104,000 gallons, against 76,351,000 gallons in 1909. The share of the United States in this trade was 51,440,000 gallons in 1910, and 44,200,000 in 1909. The imports of American oil into Hongkong in 1910 were 9,160,000 gallons.

ELECTRICAL OPERATION OF THE WEST JERSEY & SEASHORE RAILROAD.[1]

BY B. F. WOOD.

The proceedings of our engineering societies abound in papers and discussions on the merits of steam and electric operation of railroads in which data are used, which to a large extent are lacking in figures taken from the actual cost of operation. A general impression prevails that operating officers of railroads will not consent to the publication of their operating costs. This to some extent may be true, but where such figures are correctly understood and properly used there should be no objection to their publication.

When the question of presenting certain data pertaining to the operation of the electrical portion of the West Jersey & Seashore Railroad before the American Institute of Electrical Engineers was discussed



MAP OF THE West Jersey and Seashore RAILROAD SYSTEM

with the management of the Pennsylvania Railroad, the reply was made that not only would the information be furnished but that it would be a pleasure to have such information made public through the proceedings of the Institute. The following data were taken direct from the operating records with only such additions as would make them more readily understood. No effort has been made to curtail or to modify in any respect the data selected.

It is the object of this paper to present these data in as concrete form as possible without comparison with the operation of the parallel steam service, and no attempt will be made to analyze or compare the data with any that have heretofore been presented.

[1] Abstracted from a paper presented at the Twenty-eighth Annual Convention of the American Institute of Electrical Engineers, Chicago, Illinois, June 28, 1911.

This paper will be of value if railroad engineers are encouraged to present before the Institute similar data, and if some standard form for the compilation of such data is agreed upon. Comparisons could then be made more readily and their value enhanced.

It is hoped that a discussion will be developed which will enable operating officers and engineers to improve the efficiency, add to the reliability and reduce the costs of operation of electrically operated railroads.

The portion of the line which is electrically operated extends from Camden, via Newfield, to Atlantic City, a distance of 64.6 miles; and from Newfield to Millville, a distance of 10 miles. With the exception of the Millville Branch, which is a single track railroad, the line is double tracked with a third track extending for a distance of about six miles north from Woodbury.

This portion of the W. J. & S. R. R. was originally operated by steam and was a single track line south of Newfield. In the latter part of the year 1905 it was decided to electrify. The work was undertaken in December, 1905, and had progressed to such a point that in the early part of July, 1906, the first train was moved electrically. Regular operation by electric service was established in September of the same year.

The direct current over-running third-rail system operating at 675 volts was chosen for this installation.

A map of the West Jersey & Seashore Railroad is shown in Fig. 1, from which the electrified portion can be readily followed. The locations of the power station and the substations are shown, as well as the position of the transmission line with respect to the line of the railroad.

Cost of Construction.

A table is included showing the cost of construction in connection with the electrification and includes costs made necessary by electrification. It will be noted that the electrification costs represent less than half of the total cost involved in the change of motive power.

Costs are also presented showing the unit costs of power station transmission line, substations, etc.

COST OF CONSTRUCTION.

Power Stations:		
Building, stacks, coal and ash handling machinery	$354,000	
Equipment	640,900	
Total		$994,900
Transmission line		241,500
Substations:		
Buildings	72,000	
Total		491,560
Third rail		557,636
Overhead trolley		80,500
Track bonding		102,659
Cars		1,135,900
Car repair and inspection sheds		46,674
Right-of-way, additional		592,100
Reconstructing tracks		763,800
Constructing new tracks		2,071,000
Terminal facilities and changes at stations		252,400
Signals and interlocking plants		561,900
Changing telegraph and adding telephone facilities		105,100
Fencing right-of-way, cattle guards, etc.		88,400
Miscellaneous items		44,200
Total		$8,130,229

UNIT COST OF ELECTRIFICATION.

Power station, cost per kw	$ 124.36
Transmission line, cost per mile	3,485.00
Substations, building and equipment cost per kw	28.90
Third rail, cost per mile	4,235.00
Overhead trolley, cost per mile	4,120.00
Track bonding, cost per mile	684.50
Cars, including electrical equipment each	12,214.00

Cost of Operation and Maintenance.

The cost of operation and maintenance is shown under several headings as follows:

1. Cost of operation in cents per car mile.
2. Cost of operation and maintenance of Westville power station.
3. Cost of maintenance of high-tension transmission line.
4. Cost of operation and maintenance of substations.
5. Cost of maintenance of third rail.
6. Cost of maintenance of trolley.
7. Cost of maintenance of bonding.

TABLE I
WEST JERSEY & SEASHORE RAILROAD
Electric train service
Passenger train statistics
Cost of operation in cents per car mile

Year 1909

	Repairs, Electric Equipment of Cars.	Repairs Passenger Cars.	Other Maintenance of Equipment Costs.	Electric Power at Car Shoes	Yard Service Shifting Costs	Motormen	Trainmen.	Train Supplies and Expenses.	Total.	Other Expenses	Total Expenses.	Car Miles. Total.	Average Cars per Train.
January	1.06	2.05	0.48	4.78	0.51	0.93	1.53	1.20	12.53	10.25	22.78	279,210	3.113
February	1.07	2.42	0.38	4.63	0.51	0.91	1.49	1.22	12.63	10.99	23.62	258,130	3.163
March	1.18	1.97	0.35	4.99	0.52	0.99	1.65	1.18	12.83	10.17	23.00	279,193	3.092
April	1.26	2.03	0.25	4.43	0.46	0.89	1.40	0.61	11.32	9.14	20.46	317,963	3.483
May	0.84	1.73	0.26	3.98	0.44	0.88	1.45	0.45	10.03	9.18	19.21	318,006	3.482
June	0.40	0.68	0.31	3.58	0.27	0.86	1.41	0.42	7.91	9.35	17.26	339,294	3.530
July	0.33	0.44	0.12	2.82	0.20	0.80	1.25	0.40	6.36	6.95	13.31	478,203	3.669
August	0.28	0.40	0.14	2.75	0.20	0.75	1.18	0.36	6.06	6.29	12.35	517,223	3.921
September	0.43	0.67	0.14	2.75	0.25	0.84	1.32	0.42	6.81	6.87	13.68	428,571	3.584
October	0.64	0.71	0.24	3.84	0.31	0.92	1.53	0.62	8.81	10.21	19.02	307,825	3.046
November	0.52	0.39	0.29	3.85	0.29	0.95	1.70	0.82	8.81	9.30	18.15	291,816	3.327
December	0.87	1.08	0.2[illegible]	12.31	0.30	1.00	1.72	1.30	18.87	15.05	33.92	292,175	3.318
Avg.	0.68	1.10	0.25	4.30	0.33	0.88	1.44	0.69	9.67	9.08	18.75	4,107,609	3.457

Year 1910

	Repairs, Electric Equipment of Cars.	Repairs Passenger Cars.	Other Maintenance of Equipment Costs.	Electric Power at Car Shoes	Yard Service Shifting Costs	Motormen	Trainmen.	Train Supplies and Expenses.	Total.	Other Expenses	Total Expenses.	Car Miles. Total.	Average Cars per Train.
January	0.86	1.03	0.67	4.59	0.46	0.96	1.64	2.24	12.45	7.22	19.67	292,523	3.169
February	0.79	1.78	0.33	5.38	0.50	0.97	1.48	1.07	12.30	12.44	24.74	262,488	3.137
March	1.04	1.13	0.28	3.87	0.48	0.88	1.51	0.89	10.08	12.91	22.99	333,252	3.445
April	0.62	0.76	0.31	4.57	0.49	0.97	1.62	0.70	10.04	11.55	21.59	302,463	3.344
May	0.57	0.78	0.24	2.78	0.48	0.89	1.41	0.44	7.59	9.92	17.51	351,994	3.651
June	0.79	0.67	0.24	2.80	0.45	0.97	1.62	0.58	8.12	10.13	18.25	375,023	3.406
July	0.44	0.46	0.18	2.47	0.34	0.89	1.39	0.36	6.53	6.66	13.19	565,787	3.641
August	0.29	0.57	0.15	2.48	0.33	0.85	1.38	0.37	6.42	5.62	12.04	594,852	3.811
September	0.37	0.54	0.21	2.71	0.39	0.85	1.42	0.42	6.91	7.34	14.25	487,543	3.771
October	0.73	1.19	0.28	3.05	0.47	0.91	1.69	0.52	8.84	12.34	21.18	339,789	3.564
November	1.40	2.45	0.47	3.71	0.51	0.96	1.71	0.54	11.75	10.58	22.33	311,882	3.379
December	0.63	1.94	0.21	3.93	0.51	0.93	1.71	0.74	10.60	12.13	22.73	334,936	3.494
Avg.	0.66	1.01	0.27	3.33	0.43	0.91	1.52	0.67	8.80	9.39	18.19	4,552,532	3.518

Table I shows the cost of operation for the years 1909 and 1910, in cents per car mile, and subdivides the cost of operation into the general headings, repairs, electric equipment of cars; repairs, passenger cars; other maintenance of equipment costs; electric power at car shops; yard service, shifting cost; motormen; trainmen; train supplies and expenses; total of above; other expenses; total expenses. The table also shows the total car miles per month and the average cars per train. The headings of this statement are probably sufficiently explanatory, other than "other expenses," which includes cost of maintenance of way and structures, despatching trains, telephone and telegraph, crossing gatemen, together with traffic expenses and general expenses.

Table II shows the cost of operation and maintenance of the Westville power station for the year 1910. This statement is subdivided under the general headings of operation and maintenance and under the further sub-headings of material and labor. The statement shows the total monthly cost as well as the cost in cents per kw.-hr. for each item.

The total net output from the station is also shown as well as the pounds of coal per kw.-hr. and the cost of coal per ton of 2000 lb.

TABLE II
WEST JERSEY AND SEASHORE RAILROAD
ELECTRIC TRAIN SERVICE
COST OF OPERATION AND MAINTENANCE OF WESTVILLE POWER STATION
YEAR 1910

Items	January Total	January Cents per kw-hr	February Total	February Cents per kw-hr	March Total	March Cents per kw-hr	April Total	April Cents per kw-hr	May Total	May Cents per kw-hr	June Total	June Cents per kw-hr
OPERATION — Labor — Boiler room	1,069 73	0 050	1,074 82	0 058	1,153 75	0 053	1,289 59	0 064	1,189 41	0 056	1,187 22	0 055
Turbine	803 59	0 038	806 95	0 044	771 83	0 036	828 21	0 041	854 00	0 040	795 88	0 037
Electrical	133 69	0 006	135 18	0 007	131 53	0 006	140 37	0 007	142 71	0 007	138 75	0 006
Supervision janitors and watchmen	431 09	0 020	388 56	0 021	371 13	0 017	188 13	0 009	169 83	0 008	164 15	0 007
Total operating labor	2,438 10	0 114	2,404 51	0 129	2,428 21	0 112	2,446 30	0 121	2,355 97	0 111	2,286 00	0 105
Material — Coal	7,725 33	0 363	7,049 28	0 378	7,769 57	0 358	7,161 62	0 353	7,575 21	0 358	8,262 96	0 381
Water	41 67	0 002	41 67	0 002	41 68	0 002	41 67	0 002	41 66	0 002	41 65	0 002
Lubricants									40 72	0 002	38 27	0 002
Misc material	200 62	0 010	121 51	0 007	234 71	0 011	137 25	0 007	75 38	0 004	78 33	0 004
Misc charges	124 10	0 005	120 88	0 006	112 40	0 005	116 80	0 005	141 48	0 007	172 80	0 008
Total operating material	8,091 72	0 380	7,333 34	0 393	8,158 36	0 376	7,465 31	0 367	7,877 45	0 374	8,594 01	0 397
Total operation	10,532 82	0 494	9,737 85	0 522	10,586 60	0 488	9,911 84	0 488	10,233 42	0 484	10,880 01	0 502
MAINTENANCE — Labor — Building	13 04	0 001	4 91	0 000	4 41	0 000	67 21	0 003	45 20	0 002	31 89	0 001
Boiler room	79 67	0 004	148 68	0 008	191 89	0 009	220 67	0 011	159 46	0 008	82 21	0 004
Turbine	42 13	0 001	18 48	0 001	118 85	0 005	30 66	0 001	29 64	0 001	97 10	0 004
Auxiliary apparatus	30 74	0 002	43 22	0 004	34 71	0 002	31 44	0 001	43 22	0 002	189 25	0 009
Electrical	0 56	0 000	1 95	0 000	13 57	0 001	15 92	0 001			15 46	0 001
Piping	35 74	0 001	39 47	0 002	48 03	0 002	73 02	0 001	72 23	0 003	70 84	0 003
Miscellaneous	36 49	0 002					13 68	0 001	31 11	0 002	65 54	0 003
Total maintenance labor	237 37	0 011	289 71	0 016	410 46	0 019	452 60	0 022	371 76	0 018	552 58	0 025
Material — Building	8 26	0 000	3 63	0 000	10 76	0 001	12 01	0 002	44 92	0 002	13 81	0 001
Boiler room	145 62	0 007	304 04	0 016	249 03	0 012	231 07	0 011	89 60	0 004	196 62	0 009
Turbine	3 19	0 000	125 41	0 007	364 54	0 017	410 23	0 022	88 04	0 004	25 15	0 001
Auxiliary apparatus	26 35	0 001	144 10	0 008	44 30	0 002	58 26	0 003	67 66	0 003	264 32	0 012
Electrical	0 60	0 000	0 74	0 000	4 82	0 000			3 12	0 000	83 79	0 004
Piping	9 96	0 001	21 97	0 001	31 81	0 001	52 29	0 003	12 16	0 001	42 66	0 002
Miscellaneous			52 97	0 003	49 21	0 002	40 67	0 002			87 87	0 004
Total maintenance material	194 98	0 009	652 86	0 035	752 46	0 035	864 53	0 043	305 50	0 014	714 22	0 033
Total maintenance	431 35	0 020	942 57	0 051	1,162 92	0 051	1,317 13	0 065	679 26	0 032	1,266 80	0 058
SUMMARY — Total labor	2,675 47	0 125	2,694 22	0 145	2,838 70	0 131	2,898 90	0 143	2,729 73	0 129	2,838 58	0 130
Total material	8,288 70	0 389	7,986 20	0 428	8,910 82	0 411	8,329 87	0 410	8,182 95	0 387	9,308 23	0 430
Total labor and material station proper	10,964 17	0 514	10,680 42	0 574	11,749 52	0 542	11,228 77	0 553	10,912 68	0 516	12,146 81	0 560
Other items charged to station accounts	143 83	0 007	144 86	0 007	137 83	0 006	192 62	0 009	197 62	0 009	174 19	0 008
Total	11,108 00	0 521	10,825 28	0 580	11,887 35	0 548	11,421 39	0 562	11,110 30	0 525	12,321 30	0 568
Net output	2,131,000		1,865,300		2,168,600		2,031,400		2,115,900		2,167,500	
Lbs coal per kw-hr	3 311		3 46		3 27		3 223		3 269		3 14	
Cost of coal per 2000 lbs	$2 19		$2 19		$2 19		$2 19		$2 19		$2 42	

Items	July Total	July Cents per kw-hr	August Total	August Cents per kw-hr	September Total	September Cents per kw-hr	October Total	October Cents per kw-hr	November Total	November Cents per kw-hr	December Total	December Cents per kw-hr	Year Total	Year Cent per kw-hr.
OPERATION — Labor — Boiler room	1,314 55	0 047	1,386 02	0 045	1,319 78	0 051	1,239 95	0 056	1,224 86	0 052	1,293 66	0 047	14,742 36	0 052
Turbine	857 18	0 031	855 69	0 028	866 82	0 033	866 06	0 039	861 18	0 036	843 42	0 031	10,010 81	0 035
Electrical	141 89	0 005	138 10	0 004	135 46	0 005	139 48	0 006	140 89	0 006	142 97	0 005	1,661 02	0 006
Supervision janitors and watchmen	181 20	0 007	171 67	0 006	176 60	0 007	179 14	0 008	166 53	0 007	168 20	0 006	2,756 23	0 010
Total operating labor	2,494 82	0 090	2,551 48	0 083	2,498 66	0 096	2,424 63	0 109	2,393 46	0 101	2,418 25	0 089	29,170 42	0 103
Material — Coal	9,849 62	0 354	10,578 06	0 343	9,592 80	0 370	7,908 66	0 355	8,770 38	0 368	10,463 82	0 379	102,715 31	0 364
Water	41 67	0 001	41 68	0 001	41 68	0 002	41 66	0 002	41 66	0 002	41 65	0 002	500 00	0 002
Lubricants	47 37	0 002	101 21	0 003	25 74	0 001	35 63	0 001	40 05	0 001	75 92	0 003		
Misc material	117 62	0 005	131 95	0 004	167 39	0 007	169 71	0 008	156 81	0 007	208 25	0 007	2,238 44	0 007
Misc charges	124 60	0 004	214 98	0 007	210 77	0 009	127 00	0 006	117 33	0 005	96 35	0 003	1,700 49	0 006
Total operating material	10,210 88	0 366	11,066 88	0 358	10,058 38	0 389	8,282 66	0 372	9,126 23	0 383	10,885 99	0 394	107,154 24	0 378
Total operation	12,705 70	0 456	13,618 36	0 441	12,557 04	0 485	10,707 29	0 481	11,519 69	0 484	13,334 24	0 483	136,324 66	0 481
MAINTENANCE — Labor — Building	8 08	0 000	11 02	0 000	58 29	0 002	20 54	0 001	37 55	0 002	21 15	0 001	326 29	0 001
Boiler room	104 35	0 004	127 66	0 004	129 76	0 005	97 50	0 004	121 98	0 005	86 71	0 003	1,550 44	0 005
Turbine	52 75	0 002	10 96	0 000	22 57	0 001	51 40	0 002	47 35	0 002	294 22	0 011	846 11	0 003
Auxiliary apparatus	84 34	0 003	174 36	0 006	49 20	0 002	22 06	0 001	134 89	0 006	8 74	0 000	844 17	0 003
Electrical	75 56	0 003	26 21	0 001	21 53	0 001	4 47	0 000	10 15	0 000	6 92	0 000	195 30	0 001
Piping	66 10	0 002	75 10	0 003	52 34	0 002	57 25	0 003	57 07	0 002	44 76	0 002	691 94	0 002
Miscellaneous					20 66	0 001	16 52	0 001					187 30	0 001
Total maintenance labor	391 18	0 014	428 31	0 014	354 35	0 014	269 74	0 012	408 99	0 017	462 50	0 017	4,631 55	0 016
Material — Building	1 74	0 000	1 71	0 000	10 87	0 000			5 17	0 000	3 75	0 000	146 63	0 001
Boiler room	68 01	0 003	109 73	0 004	148 02	0 006	546 11	0 025	170 24	0 007	235 14	0 009	2,493 23	0 009
Turbine	24 05	0 001	76 86	0 002	67 58	0 002	361 11	0 016	8 08	0 001	14 29	0 000	1,597 52	0 006
Auxiliary apparatus	8 78	0 000	1,342 58	0 043	22 69	0 001	28 81	0 001	19 48	0 001	67 36	0 003	2,066 13	0 007
Electrical	2,924 12	0 105	0 85	0 000	13 02	0 000	6 74	0 000	0 14	0 000	8 50	0 000	3,046 44	0 011
Piping	9 74	0 000	10 66	0 000	40 02	0 002	106 49	0 005	24 73	0 001	21 48	0 001	383 97	0 001
Miscellaneous	84 46	0 003									283 88	0 010	599 06	0 002
Total maintenance material	3,103 34	0 112	1,532 39	0 049	302 20	0 011	1,049 26	0 047	227 84	0 010	634 40	0 023	10,332 98	0 037
Total maintenance	3,494 52	0 126	1,960 70	0 063	656 55	0 025	1,319 00	0 059	636 83	0 027	1,096 90	0 040	14,964 53	0 053
SUMMARY — Total labor	2,886 00	0 104	2,979 79	0 097	2,853 01	0 110	2,694 37	0 121	2,802 45	0 118	2,910 75	0 106	33,801 97	0 119
Total material	13,314 22	0 478	12,599 27	0 407	10,360 58	0 400	9,331 92	0 419	9,354 07	0 393	11,520 39	0 417	117,487 22	0 415
Total labor and material station proper	16,200 22	0 582	15,579 06	0 504	13,213 59	0 510	12,026 29	0 540	12,156 52	0 511	14,431 14	0 523	151,289 19	0 534
Other items charged to station accounts	189 88	0 007	199 84	0 007	184 06	0 007	182 68	0 008	199 52	0 008	213 37	0 008	2,160 60	0 008
Total	16,390 10	0 589	15,778 90	0 511	13,397 65	0 517	12,208 97	0 548	12,356 04	0 519	14,644 51	0 531	153,449 79	0 542
Net output	2,784,300		3,088,300		2,590,400		2,229,000		2,381,500		2,759,300		28,312,500	
Lbs coal per kw-hr	3 16		3 058		3 306		3 168		3 288		3 386		3 246	
Cost of coal per 2000 lbs	$2 24		$2 24		$2 24		$2 24		$2 24		$2 24		$2 235	

An improvement will be noted in the reduction of cost of power, as well as a reduction in coal consumption per kilowatt hour. The most marked improvement, however, will be noted in efficiency of transmission and conversion, which is accounted for by the fact that the operation of the substations is followed up with care so as to minimize the idle operation of rotaries.

OIL ENGINES FOR SHIPS.

Of much interest to the West in general, and California in particular, is the rapid growth in the use of oil for ocean-going vessels. The prediction is made that this year will show a very great advance in the use of oil engines as the motive power for ocean-going vessels. A recent writer on this subject has stated that it is not improbable that within the next two or three years ships with no funnels or boilers will be making regular passages across the Atlantic.

The continent, however, and not Great Britain has taken the initiative thus far in this important matter. Only one vessel of size to be equipped with oil engines is at present being built for registration under the British flag, although it is stated that a London firm of shipowners is about to place an order for a vessel of about 6000 tons.

Two vessels to be fitted with oil engines are being built for the Danish East Asiatic Co., while a 6000 [illegible] is nearing completion for the Hamburg-American Line, and [illegible] contract for the Brazil service of the Hamburg-South American Co. A five-masted bark of 3272 tons [illegible] is building in Germany, which will be [illegible] internal combustion engines.

The desirability of the [illegible] engines for the propulsion of large vessels was the subject of discussion not long ago at a meeting of the British Institution of Naval Architects in London. One speaker said that he knew of 250 ships which were fitted or to be fitted with Diesel plants. The most important field so far had been that of submarines, in which France took the lead seven or eight years ago. To-day the engine was almost universally adopted for that kind of ship by the admiralties of all countries except England and the United States. The number of such submarine boats was about 150, and their horsepower varied from 300 to 5000. In the last two years the radius of action and the power of these boats had so increased that the vessels were no longer merely defensive boats attached to harbors and coasts, but had become extremely dangerous for offensive purposes on the high seas. A number of gunboats and very small cruisers, especially for Russia, had been fitted with the engines. The second important field was that of the tank boats for the transport of oil in Russia. Among various other types of boats in which the engine was used was a special vessel for an expedition to the North Pole.

A department of electricity is [illegible] the new department to have charge of the [illegible] lighting of the city, police and fire alarm systems, electrical installation and repair [illegible] testing.

WESTERN RED CEDAR.[1]

BY [illegible]

[illegible] red cedar has a weight of 23.7 pounds per cubic foot, a specific gravity of 0.38, an ash of 0.17 per cent of dry weight [illegible], a fuel value of 51 per cent of white oak, a breaking strength of 10,500 pounds per square inch.

In character and qualities it is light, soft, not strong, brittle; grain coarse, even, and straight, compact; annual rings rather wide and even; summerwood about half the width of the ring, dark colored, [illegible] medullary rays numerous, obscure; color dull brown tinged with red, the thin sapwood nearly white; easily worked; durable in positions exposed to decay.

Its growth varies in height from 100 to 150 feet, exceptional trees 200; diameter 3 to 8, extreme 16 feet.

The western red cedar grows in sufficient abundance over an area of 300,000 square miles to make it attractive to lumbermen. This region embraces portions of northern California, Oregon, Washington, Idaho, British Columbia, and Alaska. The principal [illegible] Washington, and that State may be considered as the center of supply. The [illegible] of abundant rainfall [illegible] Its ex- [illegible] estimates [illegible] It is certain [illegible] that [illegible] It is not [illegible] near [illegible] is very [illegible] has been for years.

[illegible]

[illegible] Trunks [illegible] years [illegible] 1,500 years [illegible] been

[illegible] Dept. of Agriculture.

fully substantiated. It is well known, however, that trunks that fell in damp woods centuries ago have lain beneath moss and soil until the present day in a sound condition. Timber of this kind figures to a limited extent in the lumber supply. Logs dug from swamps, or exposed to view when the moss and humus have been burned off, are sometimes manufactured into shingles or lumber. Cases are vouched for in which the ages of trees growing upon buried logs show that the prostrate trunks fell five or six centuries ago, and even more, and though they have lain so great a period they are found fit for merchantable lumber.

The Indians made much use of western red cedar before white men became acquainted with the region in which it grew. From it they obtained food, clothing, shelter, means of transportation, and apparatus for fishing and the chase. From the tree trunks the savages made canoes of all sizes, from the small trough that carried two men to the enormous dugouts that transported 50 or more upon long expeditions in war and peace. Before the Indians obtained metal tools from white traders they hollowed their canoes with fire and with their primitive stone and bone implements. Some of their dugouts are of enormous size, hewed from single trunks, and with lines so perfect that civilized men can scarcely suggest improvement.[1] The making of a canoe of moderate size, by the crude means at the Indians' command in the early days, required several months of hard labor with flint adzes that chipped away pieces of wood not much larger than grains of sawdust.

When Lewis and Clark crossed the Rocky Mountains and reached the tributary waters of the Columbia River in the summer of 1805, they saw for the first time the canoes of the Indians made of this wood. Some months later when the explorers found it necessary to abandon their pack animals and trust to the rivers to carry them to the Pacific, they made their canoes of cedar, and the small fleet successfully descended the Columbia and carried the explorers to the ocean. So common was the use of this wood for dugouts that with many persons its only name was canoe cedar.

The Indians nearly always made their totem poles of this wood, because it is soft and they could work it easily with their rude tools. It was valued likewise because it resisted decay a long time, and when the grotesquely carved pole had once been set up in the village or at the cemetery, it could be reasonably expected to stand at least during the lives of those who made it and set it up. Some of these gigantic trunks hewed in forms of men and beasts, often with considerable skill, are the largest pieces of single wood carving in the world, greatly exceeding in size the largest columns and doors of European cathedrals.

The Indians of the region where western red cedar abounded generally chose it for such rude carpentry as they were capable of doing. Their choice was due to the softness of the wood, which meant a great deal to men who hewed and shaped their beams and doors with no better tools than fire, flint, bone, and shell. They made fully as much use of the bark as of the wood. With it they roofed, ceiled, floored, and papered their huts. They wove long strips of bark—sometimes 30 feet in length—into mats, which they used for beds, tables, blankets, and on ceremonial occasions. They made clothing of the same material. They twisted the bark into ropes for dog harness, ladders, fishlines, and snares for wild animals and nets for catching fish. The list of uses for the bark did not end there, for they were able to make food of it. They beat the bark to a pulp, baked it in cakes, and after completely saturating it with salmon oil they pronounced it a palatable and nutritious article of diet. It is believed, however, that the food value of the cakes was derived more from the fish oil than from the bark.

The first white settlers in the region adopted many uses of this wood from the Indian, but the chief was for canoes. What the yellow poplar was as a canoe wood to the early settlers in the East the western red cedar was to the frontiersman and trader in the Pacific region from Alaska southward.

Its value for shingles was early discovered, and as soon as the cabin took the place of the woods camp the shingle roof put in an appearance. The doors and window frames, as well as joists and rafters, were frequently of the same material. The wood's softness had tempted the Indians to use it, and the same property appealed to the white men who succeeded the Indian as the possessor of the country. It was one of the first woods cut for fences, and for many years it was commonly so used wherever it was within reach. It was employed for rails and for posts, and its long resistance to decay is shown by the fact that some of the fences built nearly half a century ago were doing service until very recently.

In the days when cooperage was handwork on the Pacific Coast, and tubs and pails were made in each neighborhood, the cedar was one of the choice woods, because convenient, easy to work, handsome in appearance, and serviceable for many years.

Western red cedar is the greatest shingle wood in the United States at this time, and has held that place for some years, with no likelihood of giving it up in the near future. The average output from this wood alone, and chiefly in the State of Washington, is not far short of 20,000,000 shingles for every day in the year. In 1908 it furnished 63 per cent of the total shingle cut of the United States. Redwood shingles, made only in California, appear with it in the eastern markets, but they form only one-eighth of the cedar output.

This cedar is extensively cut for poles in Washington and Idaho, and large size poles of this wood are now shipped to nearly all parts of the United States under the name of Idaho cedar. The very long poles seen in city streets are generally of this wood,

[1] It is claimed that canoes made by the Alaska and British Columbia Indians were early taken by fur traders to Boston and New York, where they became the patterns by which the celebrated clipper ships were built. One of the canoes, now in the National Museum in Washington, is 59 feet long, 8 feet beam, 7 feet 3 inches deep at bow, 5 feet 3 inches at stern, and 3 feet 7 inches in the middle. It was made on Vancouver Island with Indian tools, and is capable of carrying 100 persons with their camp outfits. The canoe is 19 feet longer than the Sparrow Hawk, which brought settlers from England to America in 1626. It is said that even larger canoes have been hewed from single trunks of western red cedar. A flare is given the large canoes after the hewing is done, and the width of the beam is increased 8 to 12 inches. The canoe is filled with water which is brought to a boil by dropping in hot stores. When the wood is softened by the heat, the flare is given by inserting braces.

because other woods do not afford the necessary length. Poles cut from this species taper regularly, and present an attractive appearance when set in line. Their ability to resist decay likewise adds to their value along streets and suburban roads where frequent resetting through cement and asphalt is expensive. Country telephone poles are from 20 to 30 feet long, railway telegraph poles from 25 to 40 feet, and those in cities from 40 to 75 feet.

The wood is used for car siding and roofing, positions where great strength is not required.

More is now used in boat building than in the days of the Indian canoes on western waters, but it serves in a different way. It is now a highly finished product, and is worked by skiff makers and yacht carpenters. It provides handsome trim, lining, railing and roofs.

It finds more and more demand as interior finish for houses, stores, and offices. Pattern makers use it, and it is seen in window and door frames, and in sash and doors, in molding, chair boards, stairways, panels, and porch work. It fulfills the requirements of outside finish as well as inside, and is being cut into bevel-edge siding in large quantities in many western mills. Cabinetmakers use it for many purposes—the backs and sides of drawers, shelves, boxes, and partitions. It is worked into frames and sash for hothouses, as well as sash for ordinary windows.

Its use in cooperage has come down to the present time, and where it was formerly shaped by hand it is now manufactured by machinery into buckets, pails, tubs, tanks, and the whole line of similar articles.

PUBLIC-ROAD BUILDING IN CANADIAN ROCKIES.

BY FRANK C. DENISON.

The public-road system of the Canadian Rockies is similar to that under which the roads of the Province of British Columbia are administered and is under the direction of the minister of public works in the provincial government.

Up to two years ago there was no systematic road building with a completed system of roads for the district as an ultimate object. Roads were built where temporary demands called for them, and thus some of the moneys appropriated for such purposes were not used to the best advantage. Two years ago the government at Victoria determined upon a more systematic plan, and in 1910 $65,000 was set aside for road construction in the Fernie Riding, which was found inadequate and the account was slightly overdrawn in order to complete the work laid out for that year. For the current year there has been set aside $85,000. A portion of this money is used to improve the existing roads, but the larger part is for building a 75-mile east and west trunk road from the western boundary of the riding at Wardner, on the Kootenay River, to the Alberta provincial boundary line at the summit of the Rocky Mountains, in the Crows Nest Pass, where it connects with the public-road system of Alberta. A north and south road, starting at the international boundary, at Gateway, on the east bank of the Kootenay River, and running northerly to an intersection with the east and west trunk line near the Kootenay River at Wardner, is also being improved and extended. This north and south road intersects with a good road already in use, which extends up the valley of the Kootenay River and down the Columbia River to Golden, on the main line of the Canadian Pacific Railway, where that road crosses the Columbia River.

In addition to the amounts mentioned, $15,000 has been appropriated to extend a wagon road from Corbin, the terminus of the Eastern British Columbia Railway, near the summit of the main range of the Rocky Mountains, in a southerly direction to the international boundary, on the Flathead River, where a highway from Beaton, Mont., touches the boundary line.

All bridge work in the district is done with appropriations made independently of sums voted for road work, and a considerable sum has been spent upon this class of public improvement. The latest and most expensive bridge that has been constructed in the Fernie Riding is that crossing the Elk River near where it discharges into the Kootenay, about 30 miles south of Fernie; it has spans 144 feet in length.

The trunk line of road being constructed through the district from east to west is being kept within an 8 per cent grade, and even this is to be reduced to a standard 5 per cent as the work is completed. This trunk line is but one link in a through road which is being constructed from the coast in the west to the Alberta line in the east. Another trunk line is projected from some point on the Canadian Pacific Railway, east of the Rocky Mountains, to some point on the road already built up the Kootenay and down the Columbia Rivers, which is designed to form a loop line through the mountains, which will be of sufficiently easy grade for automobile travel.

All the roads mentioned herein are intended to be so constructed when completed as to permit of automobile travel and to become a part of a provincial road system. The roads in the western part of this district, which has been longer settled, are cared for and controlled by the same system.

ILLUMINATION OF TRIPOLI.

According to consular reports, Tripoli is a city of about 40,000.

Petroleum lamps are used by everybody and quite recently the American lamp has entered the market and promises to outbid all competitors. Petroleum to the value of $25,000 is sold annually, it being the American product wholly. There is little demand for gasoline, which is used only for motor purposes. It sells at 15 francs per case of 36 liters (30 cents per gallon).

Until last May the street lighting had been very unsatisfactory, as ordinary kerosene lamps were used, but recently a German agent doing business in Tripoli persuaded the city authorities to install about 25 street lamps in the principal streets and squares. This system is called Autolux, and is manufactured by the Aktiebolaget Lux of Stockholm, Sweden. The cost of each lamp c. i. f. Hamburg is $35.46 and $34.11 for a 1,000 and 500 candlepower light, respectively.

Tripoli was treated to a rare sight the second week of June by the illumination of the Italian flour mill. An English electric plant has been installed in this up-to-date establishment.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

A great deal is being written in the technical press of the country of late about depreciation. We want to say a little about appreciation.

Educational Value of the Journal

Nearly twenty-five years ago this Journal first breathed the breath of life under the name of Pacific Lumberman, Contractor and Electrician. No bed of roses was ever strewn for it in these years of struggle for existence. Its rugged hard-earned battle has won for it a place in the heart of the West peculiarly its own. Having passed through all the trials and troubles incident to infancy and early manhood, the crisis of its life came in its nineteenth year as a result of the great San Francisco disaster. Everything belonging to the Journal was burned and almost completely destroyed by the great fire. The inventory of assets taken a few days after the calamity of 1906, showed but little aside from a good name earned by nineteen years of hard work. It was typical of that spirit of the West, of which all true westerners are justly proud, that immediately after the fire, its supporters decided that the Journal should not die. Far from it, the engineers of the west flocked to its support and not only was it decided to continue its existence but to quadruple its publication. During the immediate weeks following the fire, consequently, the Journal appeared as a weekly instead of a monthly and has so appeared since that time. In those dark days following the great disaster, never in its history did the Journal feel so deeply its hold upon its supporters. The silent, but meaning glances of approval over its brave struggle shown on all sides are never to be forgotten.

The Journal has steadily grown. Its influence has extended from a mere local field until now we feel justly proud of the whole-hearted support we are receiving from the Rockies to the Pacific. But it is not enough that our columns, through its thousands of readers, reach the buyers of 90 per cent of the power apparatus and supplies sold in the West. We want to feel that its influence as a technical educator is each day extending more widely in area and more deeply into the hearts of its readers. We appreciate the whole-hearted and almost unanimous support we have received from the managers of the big power plants and engineering concerns in the West. We want to show our appreciation by now extending our influence to reach more of their subordinates. We want to add our mite toward raising the plane of efficiency of the underman. The Journal at an early date is contemplating running a series of technical articles by men actively engaged in teaching in our great Western universities, covering such subjects as will be best adapted to the needs of Western engineers in embryo. If these articles call forth a good healthy discussion, a more earnest desire among young engineers to seek the truth in their chosen profession, we shall feel that our purpose has been accomplished.

Technical writing, like Portia's quality of mercy, "is not strained; it blesseth him that gives and him that takes."

Technical Writing

The ethics of an engineer is such that he cannot consistently advertise himself by the usual display advertisement used in the trades, nor can he solicit business in the usual methods employed in commerce. His name, his reputation, what he has formerly accomplished, must be the sole factors to secure his aggrandizement. No truer saying was ever laid down than the biblical quotation, "By their fruits shall ye judge them." The only legitimate way then, by which an engineer with proper deference to the ethics of his profession can advertise himself, is to see to it that his structures and methods become known to his fellows. In this sense technical writing blesses him that gives. Go to any engineer of reputation and he will tell you of his first start in the engineering world. He will tell you how he struggled year after year, painstakingly and often heartily discouraged till finally through some publication, his works became known and his ability appreciated.

On the other hand every engineer is a debtor to his profession. Thousands of young engineers are growing up around us who will soon have to bear the burdens of the engineering world. The experience of the older brother is of untold service in giving the younger brother a lift in life. In this latter sense technical writing blesses him that takes.

Too often when requested to write for publication, the young engineer, especially, gives a negative answer due to his belief that he lacks facility in written expression. To him the Journal wishes to make one suggestion. Go into a quiet room for a few minutes, close your eyes, think of the engineering subject in which you are intensely interested, pick up your pencil, write as you think and read the result later. You will be interestingly surprised. You will see ideas, developments, constructive imaginaion which have been carried in your mind for years, but heretofore thought by you incapable of expression.

The Journal appeals to Western engineers to submit their contributions to it for publication. The loyal and earnest support given it in the past has been the greatest factor in its present material growth. Expansion and high standard of quality are our early ambition. Hand in hand our Western development must take place. The engineer conceives new ideas. These ideas are transformed either into more efficient engineering structure or more economic methods of handling the great enterprises of the West. Our engineers then put into writing what has been accomplished and our younger men struggling along the road to learning, which philosophers of old have reminded us "is not a royal highway," are enabled to grasp new ideas and accomplish still more ideal results. The Journal feels that to be this medium of transfer of ideas is to accomplish its highest aim and it yearns through their closer co-operation to be of still great efficiency to its Western brothers.

Central Station vs. Isolated Plant

In the design of an isolated plant "team work" of its several parts is the detail which should most of all be carefully considered. Each piece of apparatus most suitable for the conditions of service under which it is to operate must be most carefully designed, and all parts of the installation must be so proportioned as to produce maximum good results and efficiency. Good design of the isolated plant will take into account the slightest thing that would tend to modify these conditions. The storage battery, the subdivision of equipment, the estimate of the proposed load, the limitations of space; the limitations of equipment to standard makes, the nearness to public service supply, and a hundred other details must come in for careful review.

The central station supply, on the other hand, usually presents two arguments, which at times prove effective in crushing the life of the isolated plant. The one is cheaper power costs, and the other is continuity of service. If the two arguments can be thoroughly shown to apply in any particular case, beyond the question of a doubt, the isolated plant loses its only excuse for existence. Very seldom, however, can this be shown; consequently the battle ground of conditions varying between costs and continuity of supply is usually the scene of a very bitter conflict.

Elsewhere in these columns will be found typical descriptions of the isolated plant in operation and results accomplished when properly designed. Also will be found noted illustrations of recent cases in which the central station service has been adjudged so superior that it has been deemed best to abandon the isolated installation. In any particular case the factors that lead to the final judgment of the one over the other necessitate the consideration of many fine and delicate points. Convincing arguments for a choice in one case will be found wholly unapplicable in a second instance. As the struggle of the one against the other continues, the upholders of both sides, due to the constantly improving of equipment and generation of power, are enabled each day to provide new arguments for their views. The isolated plant of yesterday, inefficient, costly, and of low continuity factor is found by years of careful study and correct design to be remarkably cheap in operation and practically constant in service. The great central stations of yesterday, on the other hand, receiving their power supply from the hydroelectric plants miles from the center of distribution, were found poorly equipped for continuous service. Today, however, with their giant turbo-generator auxiliaries and network connections of the several supplies the service is ideal.

Day after day the struggle between the central station and the isolated plant continues. To the nonpartisan, much good argument can be seen on both sides. The future alone can be the final judge. Like the great bug-a-boo scare of the annihilation of the horse upon the advent of the automobile, the future will undoubtedly decree definite and economic reasons for the existence of both, leaving the great Darwinian law of survival of the fittest to pass the final and eternal decree in each case.

PERSONALS.

R. D. Miller, who has gas and electric interests at Buffalo, N. Y., was at San Francisco during the past week.

Tracy E. Bibbins, of the General Electric Company's San Francisco district office, is visiting the Eastern factories.

A. Albrecht, who is interested in the New Monterey & Fresno Railroad Company's project, was a recent San Francisco visitor.

W. F. Lamme, electrical engineer, returned to his San Francisco office last Monday from a trip through the interior of the state.

Charles S. S. Forney, president of the Southern Counties Gas Company, of Los Angeles, was a recent arrival at San Francisco.

H. E. Sanderson, Pacific Coast manager for the Bryant Electric Company, is making an extensive tour of the Pacific Northwest.

A. B. Domonoske has accepted the position of Instructor in Mechanical Engineering at the State University and is now busily engaged in planning his work for the year.

H. R. Noack, manager of Pierson, Roeding & Co., is in the Kings River Canyon on a camping trip with A. H. Babcock, electrical engineer for the Southern Pacific Company.

J. S. Torrance, vice-president of the Home Telephone Company, of Los Angeles, passed through San Francisco during the past week, on his way to Klamath Lake with Col. W. H. Holabird.

George E. Pillsbury, chief engineer of the Pacific Electric Railway Company of Los Angeles, spent the past week at San Francisco, accompanied by J. A. Lothian and B. L. Dowell, of the same corporation.

K. T. Wang, a prominent engineer from China who has been visiting England this summer, sailed for the Orient last Tuesday after inspecting the various electric power plants of San Francisco and vicinity.

J. P. Jollyman, electrical engineer, has left the Great Western Power Company and will on September 1st, assume a similar position with the Pacific Gas & Electric Company under J. H. Wise, the assistant general manager.

Frank H. Ray, of New York, who is heavily interested in the Rogue River Light & Power Company, recently spent several days at San Francisco, on business connected with the new hydroelectric plant that is under construction on the Rogue River.

R. G. Hanford, who is associated with F. M. Smith and W. S. Tevis in the United Properties Company, controlling electric railways and electric power plants at Oakland and San Francisco, returned to San Francisco from New York last Thursday.

Charles Gilcrest, instructor in Electrical Engineering at the University of California, has again assumed his duties at the state institution. Mr. Gilcrest is receiving the congratulations of his friends, having taken unto himself a blushing bride during his vacation.

G. W. Howson is engineer in charge of the work which was recently commenced on the Sierra and San Francisco Power Company's new impounding dam, on the upper waters of the Stanislaus River two miles below the Relief Dam. Ford Bacon & Davis, have general supervision as engineers, and S. I. Goodfellow of the Sierra & San Francisco Power Company, is superintendent at the dam site.

Patrick Broderick, a former commissioner of public works, has been appointed by the Board of Works as superintendent of construction of the Geary Street Municipal Railway at a salary of $6,000 a year. A. M. Hunt will be continued as consulting engineer on the project. A large force of men is engaged in grading the roadbed. The trolley wire has been strung and it is expected that the road will be placed in operation as an electric line next summer, with current purchased from some existing power company.

ELECTRICAL CONTRACTORS' NOTES.

The wiring for the new home of the Knights of Columbus at San Francisco has been awarded to the Central Electric Company.

The Enterprise Electric Company of San Francisco have moved from Eighth street, near Mission, to 640 Mission street.

The wiring for the new Masonic Temple at Van Ness avenue and Market street, was awarded to the General Electric Construction Company. This firm is doing a great many large jobs, among which are the Olympic Club, County Jail, Lowell High School, Sunset Publishing Company and Central Creamery, in San Francisco, besides the Santa Cruz Postoffice, and the Nicholas Building and the Schadt Building in Sacramento. The Central Creamery building is the largest conduit job on the coast.

Secretary Hanbridge contributes the following interesting side-light on a live topic:

Why Is a Bidder?

It is with a great deal of amusement that we note the claims of some of our political engineers, that city and state work can be done cheaper by day work than by contract. We doubt the sincerity of their statements when they say so. They may advance the statement that better work can be obtained. Still we don't agree with them, as the United States Government is not suffering from poor contract work.

There is only one way to obtain good work at a fair price, and that is by placing the work in the hands of competent engineers, to lay the same out carefully, let by contract to lowest responsible bidder, then exact from the contractor what he has agreed to do to the letter—no more and no less.

By doing so, a class of contractors will seek the state and city business that will fill the list with responsible bidders. The above, in reference to results, applies to private work as well as to public.

Another practice that is not to be commended is the taking of figures on a contract and then letting it by day work, which is a practice that has been carried on in the State Engineers' office.

A recent job of electric work from the above-mentioned office brought in only three figures. The firms that submitted two of these bids had not been in business over four months, and the third, although one of the largest contractors in the United States, was bidding for the first time on California state work. The last named was low, but the usual note came from the State Engineers' office: "We consider we can do it cheaper by day work."

It costs money to estimate work; it costs money to look at the state plans, as a deposit is required to insure that the plans will be returned; it also costs money to submit a bid to the state, as a certified check is required for good faith from the contractor. Why should the state not, at least, be fair and award the work to the lowest bidder?

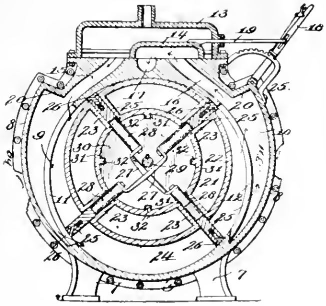
While the above applies to a practice that has been carried out by many of our state institutions, it also applies to private work as well; while every man has a right to buy where he can get the most for the least money, still we all like fair play.

MEETING NOTICES.

There will be a meeting of the Lamp Manufacturers at Camp Cloverack, Association Island, New York, for the week of Septembeh 3, 1911. The island is in Lake Ontario, about 20 miles from Watertown, N. Y. Much pleasure and profit is anticipated by all who are planning to attend.

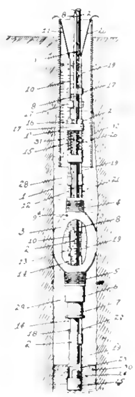
PATENTS

1,000,371. Rotary Engine. Gilbert Brickley, Missoula, Mont. A rotary engine comprising a cylinder having inlet and exhaust ports, a rotor eccentrically mounted in the cylinder, said rotor comprising inner and outer shells and a connection therebetween, the outer shell being in contact with the cylin-



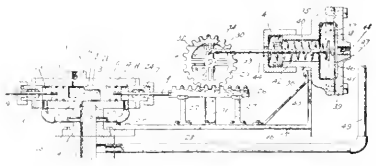
der wall at one point, radially slidable wings carried by the rotor and in contact with the cylinder wall, a shaft extending through the rotor, a disk fastened to the shaft and having a notched periphery, said disk being located within the inner shell of the rotor, and lugs on said inner shell extending into the notches.

1,000,583. Packer for Operating Gas, Water, and Oil Wells. Augustus Ste'ger Cooper, Los Olivos, Cal. A device for operating gas, water and oil wells, consisting of a dilatable and collapsible packer; means operatable from the mouth of the well to effect the expansion of said packer to cause it to close the cross sectional area of the well; means operatable from the mouth of the well to effect the collapse of the packer,



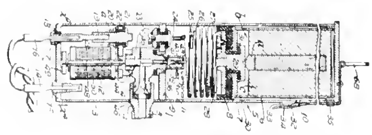
including a spring held valve acting automatically to close an outlet opening in the packer and an operating member extending to the mouth of the well; a flow pipe extending from the mouth of the well, through the packer and into the well below the packer; and means operatable from the mouth of the well to open and close the lower end of the flow pipe.

1,000,588. Balanced Valve. Clarence A. Cummings, Fresno, Cal. A balanced valve comprising a body, a gate sliding within said body and provided with a duct passing transversely therethrough, said duct having a passage extending longitudinally of said gate and having an enlarged opening on the side of said gate disposed toward the high pressure admission point, said gate having a single opening of reduced size with respect to said enlarged opening disposed on the side of said gate toward the low pressure side of said gate, said passage having an area on its upper side exposed to the



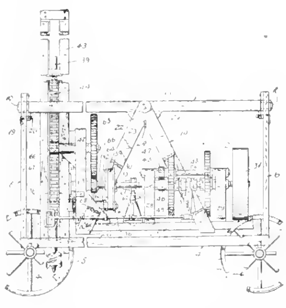
pressure within said duct tending to press said gate toward the high pressure side of said valve, and also having an area exposed to the high pressure and tending to force said gate toward the low pressure side, said gate being arranged to cut off on the low pressure side, said areas being arranged so that the pressure on said gate from the low pressure side substantially balances the pressure on the high pressure side.

1,000,972. Electropneumatic Photo-Exposure Apparatus. Karl W. Thalhammer, Los Angeles, Cal. The combination in electro-pneumatic photo exposure apparatus of an air-tank



having an outlet, a valve normally closing the outlet, means to compress air in the tank, and electro-magnetic means to open the valve.

1,000,578. Power-Driven Post-Hole Excavator. Robert T. Burdette, Los Angeles, Cal. In a machine of the class described, in combination, a main frame, wheels supporting the same and constantly resting upon the ground, a tilting frame mounted on said main frame to swing on a horizontal axis, means for locking said tilting frame, a hanger supported on



said tilting frame on a horizontal axis transversely disposed to said first axis, a guide supported on said hanger, a spindle having an auger and adapted to penetrate the earth, means for advancing said spindle on said guide, and means for rotating said spindle, said last two means being mounted on said hanger.

INDUSTRIAL

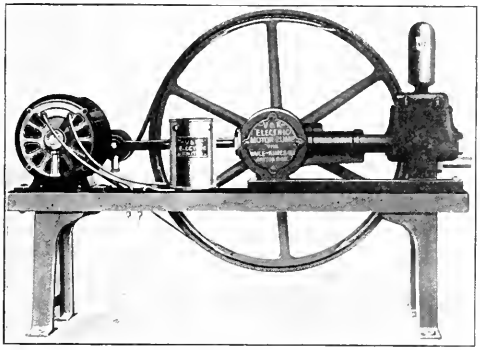
V AND K MOTOR DRIVEN HOUSE PUMP.

One of the problems that often confronts the property owner in rural and suburban districts is a troublesome and more or less crude water system. The Vaile-Kimes Company of Dayton, Ohio, are manufacturers of an electric motor pump, which, when installed with a compression, or pneumatic tank, makes an independent reliable automatic water system for all purposes. It pumps the water direct from the cistern, well, lake or stream into a tank under pressure and from there it is distributed to the house.

In cities where water rates are high or where the pressure is low, and where homes are supplied with electricity, the "V and K" pump forms are efficient and inexpensive means of water supply. It is of sufficient capacity to furnish the average suburban home with water under pressure for bath rooms, kitchen, laundry and sprinkling purposes.

The power is obtained from a 1/8 h.p. Westinghouse small motor, used so extensively for the operation of small machines.

The first cost of this little outfit is comparatively small considering its capacity and efficient operation. The operating expense is very slight, as the motor is so well designed and built that the cost of current consumed does not exceed two cents an hour.



New Type House Pump

An automatic switch, governed by the water pressure in the system, controls the operation of the motor. This switch starts the motor automatically when the pressure falls to a given point and stops the motor when the maximum desired pressure is reached. No attention is therefore required to keep up the water supply. The pump is belt driven and is equipped with an automatic belt tightener which keeps the belt always tight. A large air chamber makes the discharge smooth and uniform.

The pump may be arranged for mounting on the wall by substituting brackets instead of the legs.

WESTERN ELECTRIC EARNING AT RATE OF $66,000,000 YEARLY.

For July the Western Electric Co.'s gross sales show a falling off of 3 per cent as compared with July, 1910, but the seven months of the current fiscal year which have elapsed are 4 per cent ahead of the corresponding period of last year. It now seems unlikely that the company will realize its earlier prospects of a $71,000,000 year, but the showing to date, which is at the rate of $66,000,000 for the year, is close behind the company's high record of $69,000,000 for 1906.

In the east the company's sales reports for July compare favorably with those of July, 1910, the decrease for the month coming from the central and western districts. Cable manufacturing department shows the chief decrease, the electric supplies branch show a small gain and business in telephone apparatus being good. Inasmuch as last year the falling off in business was first noted in the East it is not unnatural that this section of the country should show some increase this year.

Abroad the company's business is satisfactory, showing a larger rate of increase than here, in fact.

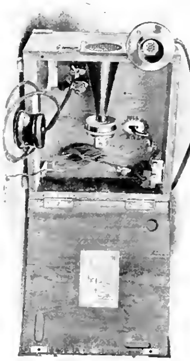
It is of interest to note that with the growth of the company, with a corresponding increase in its number of customers, the unit of orders, that it to say the average size of each order, decreases. Last year the average of sales was $72, which was considerable decrease over a period of years, and this year the unit of sales is in the neighborhood of $70. The Western Electric is employing 26,000 persons as compared with 29,000 in 1906, which was the largest number ever on the company's books at any one time. On January 1, 1909, there were less than 18,000 persons employed, which number has been increased to 23,500 approximately, at the beginning of the current year.—Wall Street Journal, Aug. 10,1911.

That the officials of the Western Electric Company are firm believers in the present prosperity and great future of the south is evinced by the fact that they will soon open a new house there. Arrangements have just been completed whereby the Western Electric Company will soon open a new house at Richmond, Virginia, where a complete stock of telephone apparatus and supplies, power apparatus and general electrical supplies will be carried. This will enable the Western Electric Company to give their customers in this territory the same prompt service which characterizes that given by the other twenty-four houses of the company's distributing organization.

Mr. H. W. Hall, formerly manager of the Denver house, will have charge of the Richmond organization, and with him will be associated specialists on the various lines handled.

COMPOSITE TELEPHONE SETS.

The signaling apparatus used with the No. 1312-A Telephone set and the No. 1314-A portable composite telephone, calls between stations by means of what is known as a howler.



New Western Electric Telephone.

When one operator wishes to call another, he presses a button in the side of the telephone set, this action automatically

starts an interrupter working, which sends out high frequency signaling current over the line and causes the howlers at the other stations to give the desired signal in a loud whistle or shriek.

No change in the telegraphic apparatus or its operation is necessary to adapt the system to telephone operation also. Each telegraph station is merely bridged with a condenser and a resistance and the telephone apparatus is connected between the line and ground. A condenser in each telephone set prevents the telegraphic current from passing through this apparatus to ground.

The sets employ local battery talking, and a condenser is bridged in series with the receiver which itself is shunted by a retardation coil. This coil prevents the telegraphic currents from passing to ground over the telegraph line beyond the telephone station, but does not impede the telegraphic currents, because these are of much lower frequency than those generated by the telephone.

It is easily possible to talk on a composited line of this character while telegraph signals are passing over it, without any interference whatever. The length of telegraph lines over which such service can be given is more or less limited. The most satisfactory operation is obtained where the telegraph is used for through business and the telephone for local business, on the same line. On a short line, service will be better and more stations can be operated than on a long line, and the usual maximum limit is generally taken at 125 miles of No. 8 B.W.G. iron wire equipped with 7 telegraph stations and 5 telephone stations.

On some railroad systems, through lines are composited over different sections, as for instance, in the case of a through telegraph circuit extending from New York to Wilmington, North Carolina which is composited between Richmond, Virginia, Rocky Mount, South Carolina. It can thus be seen that the section of line between these two points is serving a double purpose simultaneously, and thereby saving the expense of installing another circuit between these points.

NEW GENERAL ELECTRIC BULLETINS.

In Bulletin No. 4868 are illustrated and described rotary converters for railway and lighting, in capacities ranging from 25 to 2500 kw. The bulletin illustrates also a portable substation in which a converter is installed.

Motor Generator Sets is the subject matter in Bulletin 4849. It contains brief descriptions of generator sets of different styles and sizes. These sets are made up of various combinations of alternating and direct current generators and motors, and range in capacity from 95 kw. to over 7000 kw.

Bulletin No. 4858 is devoted to Single-Phase Repulsion Motors.

Bulletin No. 4866 is devoted to Thomson Instruments for Switchboard Service. This bulletin supersedes all previous bulletins issued by this company devoted to this type of instrument.

Bulletin No. 4872 describes an outfit manufactured by the company for the purification of transformer oil of all kinds, crude petroleum for oil fired furnaces, insulating varnish and japan, benzine used for cleaning purposes, transformer oil used for impregnating insulating press-board and wood, cylinder oil used in certain types of electrical apparatus, and viscous insulating compounds.

In Bulletin No. 4867 are described and illustrated electric locomotives for switching and light freight service, varying in weight from 22 to 35 tons, according to the service requirements and type of electrical equipment employed.

Bulletins No. 4837 to 4843 inclusive, form a series illustrating and describing in detail all of the circuit breakers manufactured by that company.

TRADE NOTES.

Theo. F. Dredge, Monadnock Building, San Francisco, has been appointed Pacific Coast agent for the Taylor return trap system for coil draining, water lift and automatic boiler feed.

The Yosemite Lumber Company of San Francisco, which recently purchased a Corliss engine and a complete sawmill equipment from the Allis-Chalmers Company, has ordered a 450 kw. normal rated, mixed pressure, Allis-Chalmers steam turbine generator set. Complete auxiliary apparatus has also been ordered for the new sawmill and planing mills now under construction at Merced Falls.

The General Electric Company reports the following sales: To the Bakersfield & Kern Electric Railway Company, six complete 2-motor, G. E. 203 car equipments with K-36 controllers, Sprague air brake equipments, C. P. 27 air compressors, etc. To Great Western Power Company, nine W. C. 60, 1250 k.v.a.35 C.,95,000-v.—90,000-v. primary, 24,000-v. secondary water cooled transformers with a number of full capacity taps on the secondary, ranging from 6,050 v. to 23,100 v.

With the more prevalent use of electric light and power in Evansville, Ind., the Evansville Gas & Electric Company have found it necessary to increase their generating facilities. In previous enlargements at this station, the turbine type equipment has invariably been given preference, the plant, up until a short time ago, comprising two vertical turbines and one Allis-Chalmers unit. Due to the promising growth of their electrical load, the operating company recently decided on a substantial addition to their present equipment, and accordingly placed an order with the Westinghouse Machine Company for a 1600 kw. turbine of the improved high-speed, double-flow type. The turbine will follow the familiar Westinghouse construction, partial expansion of steam taking place through a high-pressure impulse section, further expansion to a 28-inch vacuum being then effected through Parsons blading of a standard design. The electrical end of the unit comprises a Westinghouse generator normally rated at 2000 k.v.a, delivering 3-phase, 60 cycle current at 2300 volts.

NEW CATALOGUES.

The Rockwell Furnace Company of New York and Chicago has just issued Bulletin No. 29 on Labor Automatic Stop-Valve. The booklet is well illustrated covering all essential details of the stop-valve

The H. W. Johns-Manville Company, are distributing their new Electrical Supplies Catalogue No. 15, which contains over 400 pages, and illustrates and describes the Electrical Products of the company. A new solder known as Solderall is also described consisting of a non-corrosive flux, combined with solder in paste form, and contained in collapsable tubes.

The Westinghouse Electric & Mfg. Company has issued revised editions of the following sections of Perpetual Catalogue No. 3001: No. 121 on "Type CC Carbon Circuit Breakers"; No. 231 on "Expulsion Type Fuse Blocks"; No. 233 on "Outdoor Type Fuse Blocks"; No. 327 "Type C Watthour Meters"; and No. 667 on "Type KD Generator and Feeder Panels". These revised sections embody new features of interest. The following sections describe an entirely new line for switchboard meters which are very compact in size and yet retain the accuracy, the long scale and other advantageous features of the older types: No. 307 covers "Types L, SL and TL switchboard meters; No 310 "Types FM and TM switchboard meters; No. 311 Type FD and TD Frequency Meters; No. 312 Types FI and TI Power Factor Meters; No. 314 "Type TG Electrostatic Ground Detectors and Voltmeters; No. 327½ "Type OA Watthour Meters and No. 436 covers "The New Nursery Milk Warmer," while Section No. 740 covers "75 Kva. and 100 Kva. Distributing Transformers."

NEWS NOTES

FINANCIAL.

ASOTIN, WASH.—An ordinance bonding the town for $35,000 to construct a waterworks system has been passed.

SUMAS, WASH.—This place has decided to call for bids on a bond issue in the sum of $7000 for the construction of a municipal electric lighting system.

SIERRA MADRE, CAL.—The City Council passed an ordinance providing for the issuance of $40,000 waterworks bonds authorized by the voters in December, 1910.

STITES, IDAHO.—D. E. Frank, manager of the Kooskia Milling & Power Company, has applied to the city council for a franchise to furnish electric light and power.

SAN DIEGO, CAL.—John D. Spreckles bid $60,000 for a 41-year extension of franchises over all lines of the San Diego Electric Railway Co., which was accepted by unanimous vote of tne City Council.

PROSSER, WASH.—Hearing is set for September 6th for the county commissioners to decide on granting the Pacific Power & Light Company an electric light franchise at White Bluffs and Benton City.

SALEM, ORE.—Six per cent., first mortgage gold bonds of the Bay City Land Co., interest payable semi-annually are being sold for the extension of the water and electric light systems of Bay City, Ore.

PRINCE RUPERT, B. C.—The Prince Rupert Hydroelectric Company has 50 surveyors in the field preparatory to supplying power and light systems for this place. The plans call for the expenditure of $600,000 within twelve months and the total sum of $2,500,000 within four years.

LOS ANGELES, CAL.—The City Council has formally adopted the report of the finance committee, authorizing the sale as soon as needed of $525,000 each of harbor and power bonds. An extra $25,000 was added to the amount of each issue for convenience in issuing them in proper denominations.

FALLON, NEV.—The City Council has opened bids for the purchase of $35,000 waterworks bonds and $10,000 sewer bonds. Bids: Nixon National Bank, Reno, bid par or $45,000; C. H. Coffin, Chicago, bid $45,226. The latter failed to comply with requirements of furnishing certified check of 10 per cent and Nixon National Bank's bid was accepted.

ALAMEDA, CAL.—The City Council recently definitely decided on the propositions to be incorporated in the forthcoming bond issue to be held about the middle of September. The propositions as finally adopted are: For electric light plant betterments, $115,000; for park and playground equipment, $12,000; for new fire-alarm system, $75,000; for lot adjoining the electric light plant, $2500; for municipal wharf, $15,000; for portion of Saroni tract to be added to Lincoln Park, $16,000; for Hayes tract to be added to Washington Park, $30,000; for fire equipment, $30,000; for additional auto truck for West End, $6500; total $234,500.

SAN FRANCISCO, CAL.—Holding that there were no valid reasons why the affairs of the San Joaquin Valley Electric Company should be placed in the hands of a receiver on the motion of John J. Doyle, possessor of but two shares of the company's stock, or that the company should be restrained by injunction from issuing or selling $1,000,000 worth of mortgage bonds for the financing of the building operations of the company, Judge Sturtevant recently denied the petition for the appointment of a receiver and the issuance of the injunction. The trial of the petition and its accompanying suit was held August 19. The action of the court followed the presentation of arguments by Attorneys Frank H. Gould and Gavin McNab of the San Joaquin Co.'s counsel, in which it was testified that Doyle's suit was being used by the Tidewater and Southern Ry. Co., a competitor of the defendant company for the transportation business between Stockton and Modesto, as a mask behind which a campaign was being fought against the San Joaquin corporation.

INCORPORATIONS.

LOS ANGELES, CAL.—The Pacific Light and Power Co. of Los Angeles has been incorporated for $40,000,000, by H. E. Huntington, W. G. Kerckhoff, K. Cohn, G. S. Ritton, Charles Forman, A. M. Kemp and Howard Huntington.

SAN FRANCISCO, CAL.—Articles of incorporation of the Napa and Clear Lake railroad have been filed. The capital stock of the company being given as $500,000, divided into 5000 shares of $100 each. The directors are C. W. Conlisk, W. M. Rank, and R. A. Morton. The two latter have subscribed $100 each, while Conlisk has taken $109,800 worth of stock. The stated purpose of the corporation is to build a standard-gauge road from Napa to Lakeport, a distance of 90 miles.

ILLUMINATION.

KLAMATH FALLS, ORE.—An ordinance granting to the W. F. Boardman Co. a franchise for gas and heat has been passed by the council.

BURNS, ORE.—James D. Fellows has secured a 25-year electric light franchise and is purchasing machinery for the equipment of a high clas electric light plant.

SAN DIEGO, CAL.—The extension of the San Diego Consolidated Gas & Electric Company's gas mains east from City Heights to La Mesa Springs is now assured.

CHOTEAU, MONT.—Julius Hirschberg has sold the local electric light plant to H. McCullongh of Corbin, who will make repairs and furnish light by September 1st.

VANCOUVER, B. C.—The British Columbia Electric Railway Company has notified the city electrician that a large number of street lights will be installed at Hasting Townsite, and other sections.

BOISE, IDAHO.—The council has closed a contract with the Idaho-Oregon Light and Power Co. for furnishing light to the city for seven years for 300 arc lights at $126,000. A modern cluster light system will be installed as soon as possible.

LEWISTON, IDAHO.—Work will start at once on remodeling the gas plant and addition to the works of the Pacific Power & Light Company. The plans call for new brick or concrete building, equipped with modern machinery, to cost $35,000.

LOS ANGELES, CAL.—The Board of Supervisors has accepted the bid of the Southern California Edison Co. for lighting the Hawthorne Lighting District, southwest of the city at $1.25 per lamp per month, the company will set poles and string wires at once.

TACOMA, WASH.—A contract has been awarded Evans & Dickson, electrical contractors and engineers, by the Park Board for the lighting system in Wright's Park. The contract calls for the erection of ten flaming arches on 35-foot iron poles with an underground system of wiring. This work will cost about $4000.

TRANSMISSION.

LEWISTON, IDAHO.—The Nezperce Power and Light Co. is making preparations to invade the Lewiston district with power and light.

MEDFORD, ORE.—Residents of Griffin creek have voted unanimously for the construction of a pole line along Griffin creek. The county rock quarry and about forty families can be reached by this line.

SALT LAKE, UTAH.—Sealed bids will be received for the construction of hydroelectric power plant at Riverdale near Ogden according to the plans and specifications now on file at the office of the Davis & Weber Counties Canal Co., Room 316, First National Bank Building, Ogden City, Utah.

SAN JOSE, CAL.—That the Great Western Power Co. meant business when it announced its intention recently to invade the local field with a power service in competition with the Pacific Gas and Electric Co. was shown yesterday when a petition was presented to the Supervisors, asking them to advertise for sale a franchise for a transmission pole line for the entire county. The Great Western declares it is its bona-fide intention to be a bidder for the franchise. The proposed franchise will run fifty years and will carry with it the provision that the company annually, after the first five years, turn over two per cent of its gross earnings to the county.

TRANSPORTATION.

NORTH VANCOUVER, B. C.—The North Vancouver Coal & Supply Company will erect an electric hoist with a 15 horsepower motor.

MIDDLETON, IDAHO.—Plans have been completed for the new Swan Falls Power Company's substation, costing about $2500, to be built here. Lee R. Cooke, Nampa, is the architect.

MILLSIDE, B. C. It is announced that the construction will be commenced at once of the proposed extension of the British Columbia Electric Railway from New Westminster to Millside, British Columbia.

SALT LAKE, UTAH.—Applications for franchises to build street car lines on 15th East and on N. State street to the capitol building site, have been filed with City Recorder B. S. Rives, by the Utah Light & Railway Company.

LOS ANGELES, CAL.—Contracts have been made for the extension of the West Forty-eighth street car line of Los Angeles Railway corporation from the terminus at Forty-eighth and Arlington avenue through the Angelus Mesa Tract.

ARDLEY, B. C.—It is understood that the Great Northern Railway Co. will install at Ardley, British Columbia, where the Burnaby line of the British Columbia Electric Railway crosses its tracks, an interlocking plant at a cost of over $7000 which will provide for switching from one line to the other.

VICTORIA, B. C.—The Electrical Manufacturing Company has received the contract for supplying 14 miles of wire for the police alarm service, at $23 per mile, and the following: 275 cross arms at 30c each; 550 insulators, at $4.75 per 100; 500 oak pins, at $19 per 1000. The contract for 500 arc lamps will be awarded to Hutchinson Bros., at $3.35 each.

LOS ANGELES, CAL.—The construction of a broad-gauge road from Homewood to Watts, for the Redondo line of the Pacific Electric Co. is to begin at an early date. Arrangements for the franchise are now about settled. When this connecting link is completed it is the plan of the company to change the entire line from Homewood to Redondo into a broad gauge road, that broad-gauge cars might be operated through to Los Angeles by way of the four-track system between Watts and the Pacific Electric building.

TOMBSTONE, ARIZ.—F. M. Winters, Jacob Kleck, W. S. Furniss, Dr. J. M. Sweetman and C. C. Lewis will soon incorporate a company for constructing a $600,000 interurban car line connecting Hole in the Rock, Sotts-Mesa, Glendale and Pebrio, making a line 40 miles in length. Application for a franchise in Phoenix has been made to the City Council and track laying will commence in thirty days.

WOODLAND, CAL.—That the preliminary survey of the West Side Electric Railroad will be commenced this week is the announcement made by Melville Dozier Jr. of the Dozier Construction and Engineering Co. Three lines will be run between Red Bluff and Woodland, from which a permanent route will be selected. A full corps of surveyors will be placed in the field and the surveys will be made with all the speed possible with the preparation of full and accurate data. It is expected that Dozier will be able to make a report to the executive committee within five months. The survey will be begun at this city. The road is estimated to be about 120 miles in length.

SAN RAFAEL, CAL.—Geo. D. Shearer, a local real estate agent, says that he has the backing of capitalists capable of making the San Rafael Electric Road a reality if the necessary rights can be secured from the city. The franchise asked by Shearer provides for four different routes. One of these is described as beginning at the west corporate limits of the city and extending through 4th street to Irwin street, near Union Station. Another route is proposed to run from the intersection of 4th street and Petaluma avenue to the northern city limits by way of Petaluma avenue. A third line projected would extend from the corner of 4th and B streets down B street to Bay View street and thence along Bay View to Marin avenue. The fourth route is described as extending from Union Station easterly to within a quarter of a mile of Schuetzen Park.

MERCED, CAL.—The survey of the Tidewater and Southern Railroad, the electric line now being built between Stockton and Merced has reached the city limits. For several days the corps of surveyors, in charge of J. C. Lindsay, have been making their headquarters in this city while working through the British colony, a subdivision adjoining town. Byron A. Bearce, general manager of the company and J. H. Wallace, chief engineer have arrived and will go over the surveyed line between this city and the Merced River before returning to San Francisco. The line as surveyed runs from Stockton to Merced, through French Camp, Escalon, Modesto, Ceres, Turlock, and a number of smaller towns in San Joaquin and Stanislaus counties, through Irwin City, Stevinsen and Atwater in Merced County, passing through Hilmar, Jordan-Atwater and British colonies to reach Merced city. Branch lines are contemplated for Livingston, Creassey, Winton and Yam; also a branch line in this county to leave the main line in Hilmar county and run to Newman on the west side of the San Joaquin River.

SAN FRANCISCO, CAL.—The cars which the Board of Public Works is to have built by contract for the city railway on Geary street will be of the pay-as-you-enter type, all steel construction, about 53,000 pounds in weight, forty-seven feet one inch in length and with a seating capacity of forty-four Forty-three cars are to be built, completely equipped and ready for operation. The specifications provide that they shall be delivered at San Francisco within 270 days from the date of the contract. This means that the city's Geary street railway, even if the construction of the roadbed is hurried cannot be put in operation until some time next year.

Public Works Commissioner Lanmeister, who has supervised the details, visited Los Angeles, Chicago and other cities to see what equipment up-to-date street cars should have. He believes the public will be satisfied with the seating arrangements. On each side of the car there will be

seven seats for two persons, facing the front, and at the end will be a longitudinal seat on each side for four persons, all upholstered in rattan.

It was at first intended to have several open cars built for use in warm weather, but this idea was later abandoned, so none will be called for at present. When passengers wish to alight, they will press push buttons, which will be placed in the side posts, and a buzzer at each end will notify the motorman to stop. A motorman's seat is to be provided for each car. The specifications state that the desired schedule speed of the cars is to be approximately nine miles an hour, with an average of about eight stops per mile, and the maximum speed twenty-five miles per hour on level track.

TELEPHONE AND TELEGRAPH.

VANCOUVER, B. C.—It is understood that the British Columbia Telephone Company is taking a census of South Vancouver for establishing a branch exchange there.

VANCOUVER, WASH.—Lawrence Harmon has applied for a franchise for the installation of telephone and telegraph lines here and also for constructing a street car system.

DAYTON, WASH.—The Mt. Vernon Telephone Company has applied for an exclusive franchise for the right to erect poles, and construct a telephone line on certain city streets.

CORCORAN, CAL.—William Cromlie has purchased the local business of the Pacific Telephone and Telegraph Co. The central office will remain in Hotel Corcoran at present.

PASCO, WASH.—The Twin City Telephone Co. will soon spend from $25,000 to $30,000 in Pasco. A new cable plant is to be put in, work to begin this fall. R. Klingo is manager.

WASHINGTON, D. C.—The U. S. Navy Department is preparing to extend the Alaska wireless telephone system. A powerful station will be erected on one of the Aleutian Islands.

ABERDEEN, WASH.—The City Council has appointed a committee to confer with officials of the Pacific Telephone & Telegraph Company in regard to the betterment of the company's local system.

COLVILLE, WASH.—The Cedar Creek Independent Telephone Co., with its principal business at Boundary, Stevens County, Wash., has filed a petition for a franchise to construct a system of telephone lines.

LOS ANGELES, CAL.—The Pacific Telephone and Telegraph Co. has had plans prepared for and has taken bids for the erection of a three story and basement, reinforced concrete telephone building to be erected at the corner of Denker and Vernon avenues.

GREAT FALLS, MONT.—Wallace S. Perrine, supervisor of the Jefferson National Forest, south of this place, has started work on the construction of 34 miles of new telephone line in the Jefferson forest. Mr. Perrine is at present at Neihart, to institute work.

WATERWORKS.

DORRIS, CAL.—Town Clerk, F. R. Chapman, received sealed bids, until August 25th, for building the Dorris waterworks system.

ANAHEIM, CAL.—Plans and specifications for the Anaheim sewer system have been presented to the Board of Trustees and accepted.

PUYALLUP, WASH.—The commission of Tacoma has agreed on the sum of $25,000 as the purchase price of the 160 acres at Maplewood Springs, on which this place is considering the establishment of a new water system. It is probable that Puyallup will purchase the tract.

RED BLUFF, CAL.—Chas. Cofer, water locator, recently located spots for five artesian wells on the Lutheran colony land in Antelope valley.

WATSONVILLE, CAL.—The plans and specifications for a water system, filed with the Board last February by C. E. Moore, have been adopted.

COOS BAY, ORE.—Stannard & Richardson, of Portland, have been commissioned to prepare plans and specifications for a municipal water system.

NAMPA, IDAHO.—There is talk of bonding the city to raise $40,000 to extend the present water system and replace wooden pipes with cast iron.

BAKERSFIELD, CAL.—Engineer Wm. Mulholland has offered to prepare plans for a water system for East Bakersfield at a cost of between $1000 and $1500.

WOODINVILLE, ORE.—This place will meet to consider plans for the water system. It is probable that plans and estimates will be ordered and bids called for.

WOODBURN, ORE.—The City Council has under discussion a water system improvement. The kind of system needed will necessitate an outlay of $20,000. Larger pumps will be needed.

TALENT, ORE.—Postmaster T. L. Stewart, who is also an engineer, has completed a report for the trustees of Phoenix for a water system for that place. The system is gravity; estimated cost $19,120.

POCATELLO, IDAHO.—James A. Murray, owner of the Pocatello Water Co., will furnish water sufficient to supply fifty thousand people, if the council will give him permission to install a motor system.

RIVERSIDE, CAL.—The City Council has awarded a contract to the Los Angeles Manufacturing Co. amounting to over $6,000 for the construction of pipe lines and for an irrigating system for Fairmount Park.

HARLEM, MONT.—The American Light & Water Company of Chicago, has been awarded the contract for the construction of a municipal water system at this place at $30,940. Ground will be broken September 1st.

OROVILLE, CAL.—The Pacific Gas and Electric Company has had a corps of surveyors engaged in making surveys for a great storage reservoir in Oregon House in Yuba County. From the reservoirs the plans call for the water to be diverted to the Colgate power plant by means of a reservoir, which will be approximately two miles in length. It is understood that the estimated cost for the total project is in the neighborhood of $1,000,000. It is proposed by the company to erect a huge dam across Oregon House Creek, which is a branch of Dry Creek, in its turn a tributary of the Yuba River. The area covered by the water the dam would impound would be approximately 700 acres.

LOS ANGELES, CAL.—The Board of Supervisors has passed an ordinance granting to the Valley Water Co. a franchise for a period of forty years to maintain a system of water pipes in certain portions of Los Angeles County.

HERMISTON, ORE.—This place has voted bonds in the sum of $25,000 for the construction of a municipal water system. The system calls for a 250,000 gallon reservoir on Hermiston Butte and water will be transferred by a 12-inch main.

OXNARD, CAL.—The Board of Trustees has taken the initial step in the matter of municipal ownership of the water system by accepting the contract of the engineering firm of Olmstead & Gillelan to prepare plans and specifications and superintend the construction work for 8 per cent of the bond issue which is to be $100,000.

JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

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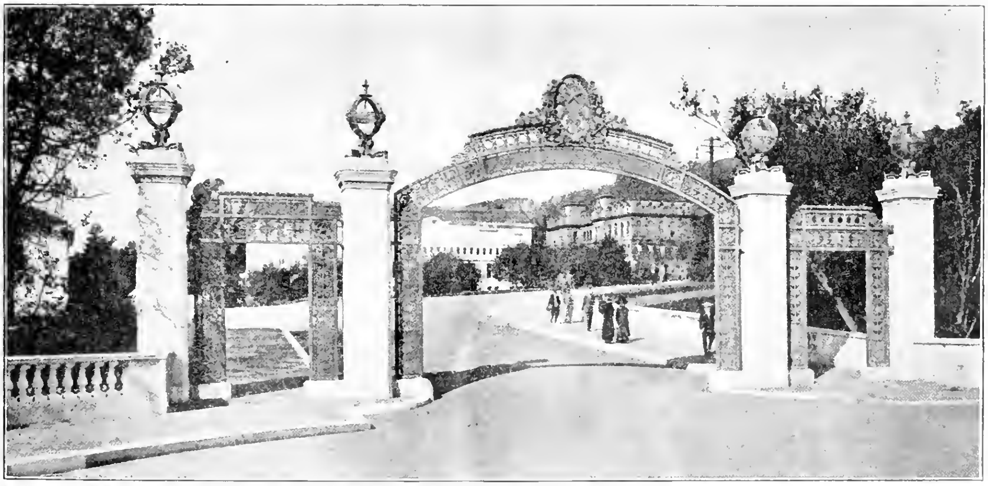
HEATING PLANT, UNIVERSITY OF CALIFORNIA

BY A. B. MEL.

Dating back to the year 1906, when the present central Power Plant and heating system of the University of California commenced operating as such, supplying steam heat to California Hall and Harmon Gymnasium, there has rapidly grown up with the University's increasing needs the present system supplying heat for over twenty of the buildings and light and power for practically every building on the Campus.

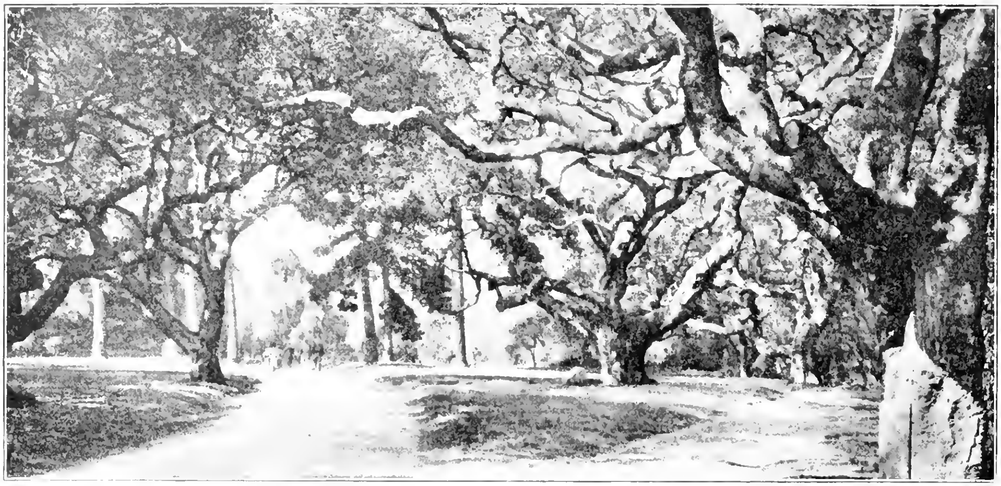


The Sather Gate, Southern Entrance to the University. Above the arch may be seen the lighting features

A faithful history would perhaps begin by describing the wood burning stoves and oil lamps in the first building, South Hall, occupied in 1873, and gradually cover the successive changes naturally following along with the additional buildings and occupied portions of the Campus, but aside from a few remarks covering this period, the article will be devoted mainly to a description of the system as it stands today.

Electricity first appeared on the Campus at Berkeley, for lighting purposes in 1896, when, through the munificence of Mrs. Hearst, the Bacon Library was wired and lighted from a 2 pole, 20 kw. Edison Type '87, 110 volt machine, then a part of the Electric Laboratory located in the Mechanics Building. A little later the night lighting in the Library was supplied from a 30 kw. 133 cycle, single phase, 1100 volt, alternator, also a part of the Laboratory equipment at the Mechanics Building. The line voltage of 1100 volts was stepped down at the Library through a transformer to 110 volts. During the day time switching was arranged so that what lights were necessary could be run from the direct current Edison machine.

At the same time a 10 light Thompson-Houston arc machine together with twenty open arc lamps were presented to the University by the Oakland Gas Light & Heat Company through John A. Britton and were installed on a series arc line around the Campus. The 10 light machine was run in series with a 15 light Wood machine, both being driven by a straight line engine located in the Mechanics Laboratory. From



Lover's Lane. Beautiful walk at western entrance to University.

this beginning the present electric light and power system grew, the arc system having been changed over first to a 25 light Thompson-Houston machine and later, in 1904, to an alternating current arc line with a larger number of enclosed arcs.

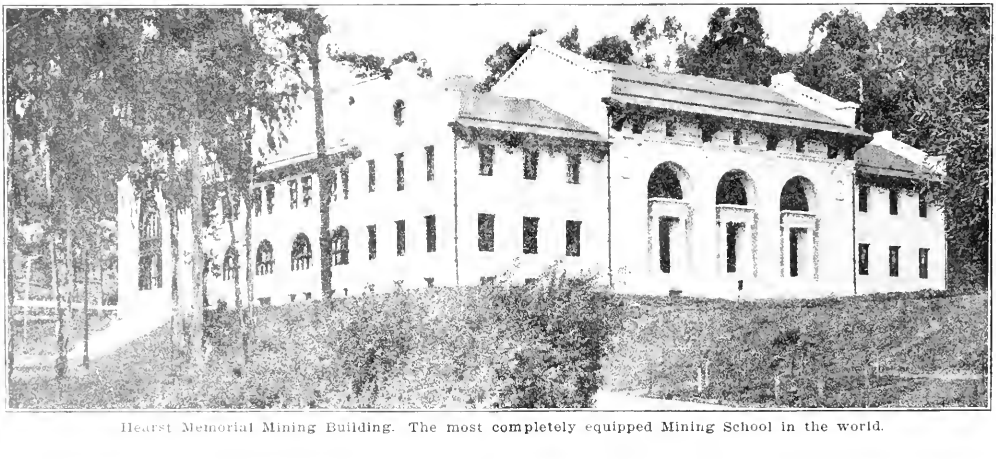
First Heating Systems.

Systematic attempts at building heating began with the erection of small individual boilers, usually of the sectional type, for either hot water or steam service, with pipe-coil or cast iron radiators. The first one was placed in the Bacon Library Building at the time of its erection in 1878 and some of the old radiators installed at that time are still in service. They are of the vertical cast iron tube type really acting as direct-indirect radiators. Also there were placed large pipe coils in boxes under the first floor. The heated air was passed up through floor registers into the central portion of the building. These registers are still faithfully serving as part of the present heating system. Other buildings as well were supplied with small heating boilers but these have gradually been eliminated one by one until at present only two buildings on the Campus are heated locally; namely, the Architectural Building, situated at the north entrance to the grounds and equipped with a cast iron sectional steam boiler and single pipe steam radiation system, and the President's house, located on the extreme north edge of the Campus, as shown in the full page map accompanying this article. In this building cast iron radiators are supplied with heat from a sectional hot water boiler.

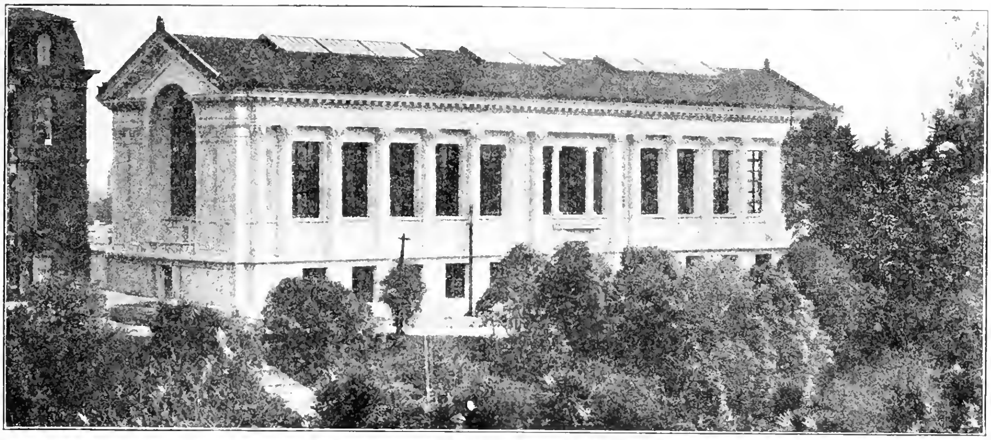
Present Power Plant.

The plant itself was erected in 1904 with three of the present boilers, the engine and necessary auxiliaries, but operation was not commenced until the fall of 1905 when, as mentioned above, heating was started for California Hall and Harmon Gymnasium. With the present rate of increase the plant will have to be duplicated within a period of two or three years.

The equipment now in service and the operating arrangement is as follows:



Hearst Memorial Mining Building. The most completely equipped Mining School in the world.



California Hall and Boalt Hall of Law. New buildings under the recent heating installation.

Boilers.

The power plant boilers consist of four Babcock & Wilcox water-tube boilers, each with 456 4 in. 16 ft. tubes and 42 in. drum, giving a heating surface of 1270 sq. ft. These operated at 140 lb. pressure, supply steam to the engine, auxiliaries, and heating system. All boilers are equipped with Peabody furnaces for oil burning with Champion burners, oil for which is pumped from a 13,000 gallon tank, located on the bank of Strawberry Creek 50 feet from the plant. The pumping equipment consists of two Snow steam pumps 3x2x3, one being kept in reserve.

The oil pump exhaust passes through a small reheater beneath the pumps. This heats the oil to about 125 degrees F. before delivery to the burners. The exhaust then passes out through a coil in the main oil tank and discharges into the creek.

B. and W. superheaters deliver the steam to the main header under a superheat of from 60 to 120 degrees, depending on the load conditions.

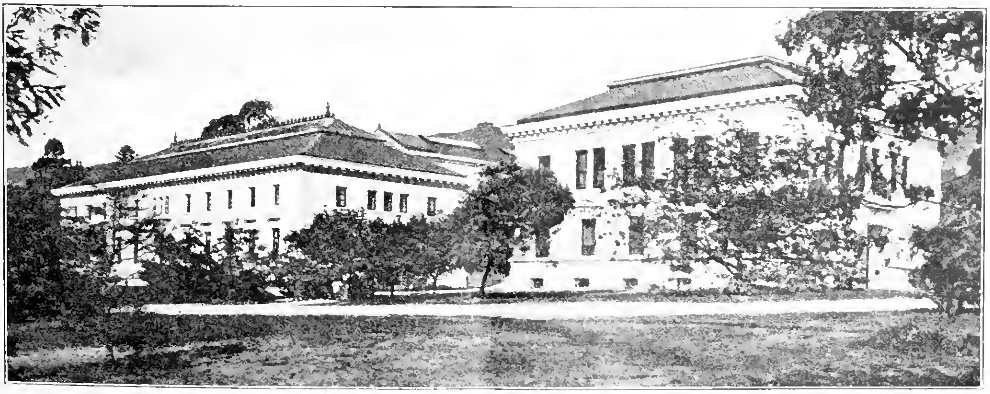
When necessary, the above boilers may be supplemented by two B. and W. boilers in the Mechanics Building on the opposite side of the Campus. These units have been installed and in operation since 1894 and 1898. Primarily, however, they are used to furnish steam for laboratory practice in the Mechanics Building and also to furnish 100 lb. steam to the Mining Building Laboratory to run a large air compressor.

Vacuum Pumps and Feed Water Pumps.

An Epping Carpenter 12x16x16x18 air circulating pump arranged with two air cylinders and one steam cylinder, arranged in tandem, handles all returns from the heating system maintaining from 12 in to 20 in. of vacuum on the system and forcing the return water into a horizontal tank receiver acting as a hot well. The returns are reheated by steam from the auxiliaries passing through a pipe coil in the receiver and discharging into the creek. The "return water," together with the necessary make up water is raised by two Snow Pump Co.'s $5\frac{1}{4}$x$3\frac{1}{2}$x3 feed pumps and discharged into a Hoppe purifier placed 4 feet above the boilers. From here the water runs by gravity to the boilers, the purifier being under boiler pressure.

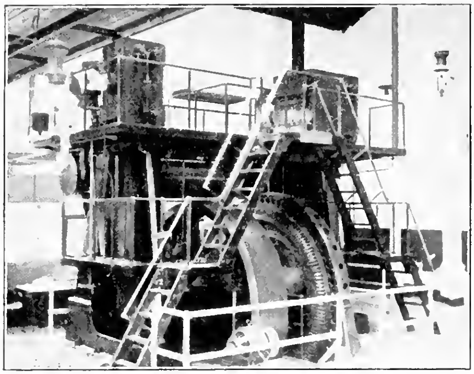
Engines.

The engine, manufactured by the McIntosh-Seymour Co., is of the vertical cross compound type 12 in x 26 in. x 30 in. stroke. It was originally designed



The Doe Library Building. This magnificent new structure at the University is to be given two stars in Baedeker's American Guide.

as a condensing engine but is now operated with a back pressure of about 5 lb. gauge on account of the exhaust being connected directly into the heating system on which this pressure must be maintained.



Power Installation at the University.

Between the low and high pressure cylinders is a reheater which delivers the steam to the low pressure cylinder under a slight superheat and at a pressure of about 30 lb. Combined with the engine governor is a motor operated McIntosh-Seymour speed changing device. A double throw switch on the exciter panel gives the operator control of this device and a variation of four or five revolutions per minute may be obtained when bringing the generator up to synchronism for parallel operation.

Generator.

The 250 kw. generator made by the Allis-Chalmers Company is of the revolving field type, having 48 poles and 72 field coils, running three phase star connected with neutral grounded. Normal load current is 28.9 amperes per phase with a terminal voltage of 4000 volts.

Battery of Boilers at the University Installation.

Excitation for the field is furnished from a motor generator set run either from the Berkeley Lighting Company's service, or the generator itself but should this source fail at starting the excitation can be had from a small 10 kw. generator driven by the main flywheel through a friction pulley. This may be clearly seen in the picture showing the interior of the power equipment.

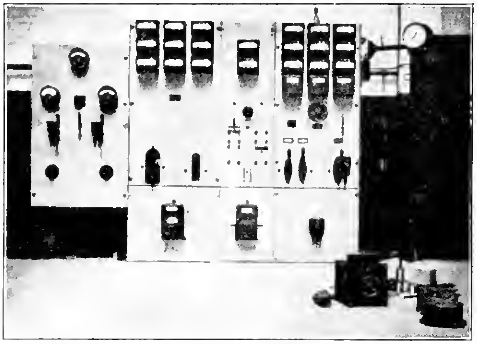
Switchboard.

An illustration in this article shows the switching arrangement. Six panels control in order from left to right as follows: (1) The direct current 220 volt three wire service, (2) Berkeley Lighting Company's incoming service, (3) the Campus distribution service, (4) an exciter panel for the generator, (5) the generator service, and (6) a starting panel for the motor generator. Oil switches are so arranged that the upper and lower Campus lines are separately controlled and either may be carried by the University's service or the Berkeley service.

As shown the three phases of both services are metered by full sets of indicating and integrating meters. Besides these panels, there is a separate panel board for the arc lighting on the Campus.

Motor Generator Set.

This set, consisting of two 50 kw. Westinghouse d.c. 110 volt generators operated in series for 220 volt 3 wire distribution, is driven by a 2300 volt 2 phase induction motor, direct connected through flexible couplings.

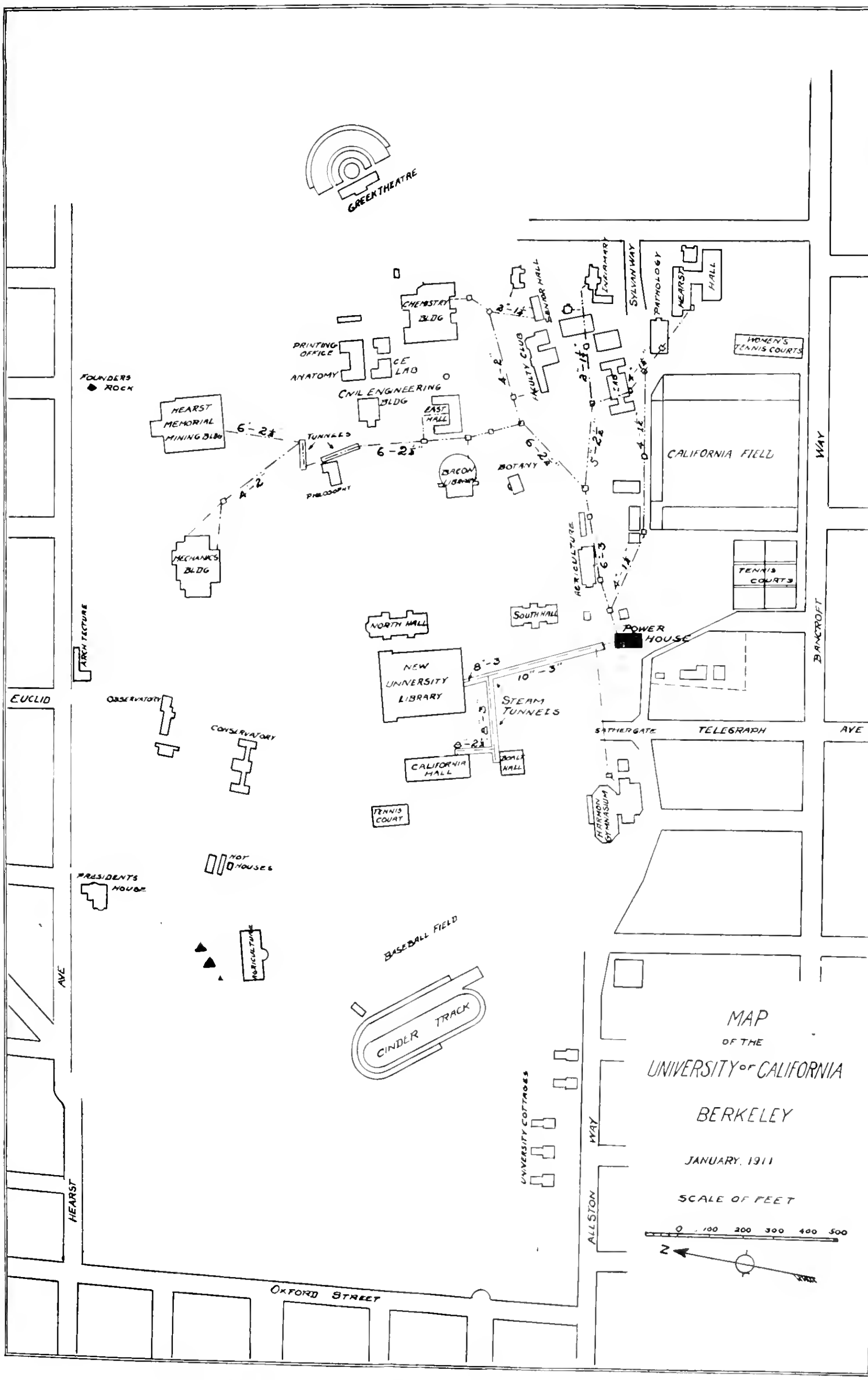


Switchboard Arrangement at the Power House.

To supply this two phase current for the induction motor, a 25 kw. 4000 to 2300 volt Hornberger transformer is connected between two of the 4000 volt leads for one phase and the 2300 volts from neutral to the third wire is taken for the second phase. This arrangement, made necessary through the failure of one of the two 75 kw. Scott connected transformers some time ago, has given satisfactory service ever since.

Heating System.

Steam distribution for Campus heating is divided into two separate parts, the lower line, providing for California Hall, Boalt Hall, Harmon Gymnasium, and the new University Library, is operated under a pressure of from 4 to 7 lb. This steam is taken from the engine exhaust when the engine is running and if this is not sufficient, as is often the case in very cold weather, sufficient "make up" to maintain the pressure



Map of Campus Showing Underground Mains and Tunnels of University Heating System.

is taken direct from the boiler, a Mason reducing valve making the reduction from the 140 boiler pressure. The pipe for nearly all of this lower Campus distribution is carried in tunnels from the plant to the buildings. The upper Campus is heated by a steam line using live steam reduced from 140 lb. to 35 lb. by an automatic Mason reducing valve and at each separate building the steam is again reduced to a pressure of about 5 lb. for the radiators.

A Portion of the Heating System Crossing Strawberry Creek.

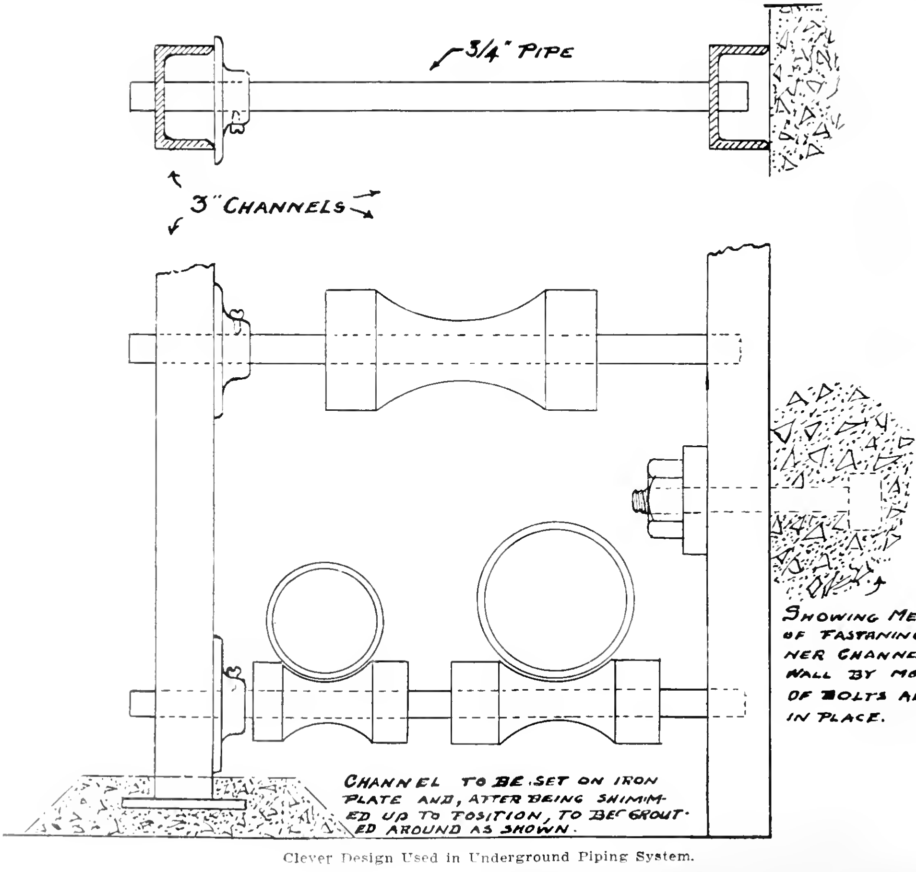
As already mentioned, this upper line is connected by a 4 in. line with the Mechanics boilers and these, in case of heavy load or when ever the main boilers have to be shut down for repairs, may be used for Campus heating.

Expansion in both steam and return pipes is taken up by sliding expansion joints placed in the 20 manholes. Anchors on the mains, subdivide the expansion so that not more than 200 ft. of pipe is expanded into any one joint.

The type of construction first used, for buried lines, placed the pipes, steam and return, in a plain wooden box of 2 in. redwood, both pipes being covered with 1 in. asbestocel of 85 per cent magnesia covering and allowed to expand on iron rollers placed at intervals of about 15 ft. on the bottom of the box.

This method has been entirely replaced within the last five years, all lines laid since then having been covered with 1 in. thickness of 85 per cent magnesia, wrapped with canvas and painted with a water proof paint. The whole is then enclosed in a salt glazed sewer tile large enough to allow a 1 in. free air space around the covering. The 2 ft. tile sections have their joints cemented to prevent seepage water from getting in around the pipe and covering a 4 in. porous drain tile is placed in the trench under the main tile to carry as much as possible of this seepage water away from the lines.

The expansion is provided for by placing tile tees



Clever Design Used in Underground Piping System.

at intervals of about 12 feet. The tee opening turned down and usually resting on a concrete base, contains a roller stand and roller on which the pipe rests and travels in expansion.

Some idea of the amount of heating supplied by the lower campus lines alone may be gained from the following data:

Building	Direct Heating	Indirect Heating
California Hall		1,700 Sq. Ft.
University Library	5,900 Sq. Ft.	1,700 Sq. Ft.
Boalt Hall	800 Sq. Ft.	750 Sq. Ft.
Harmon Gymnasium		700 Sq. Ft.
Total	6,700 Sq. Ft.	4,850 Sq. Ft.

In addition to this, steam is supplied to heat water for 150 showers in Harmon Gymnasium and hot water at the basins in all four buildings.

Tunnels.

Within the last two and a half years, the University has added to its heating and power system over 1000 feet of tunneling to provide for steam pipes and electric cables. These tunnels are located as shown in the map of the Campus and consist of 800 feet of concrete construction 6 ft. 6 in. high and 5 feet wide connecting the power plant with the new University Library, Boalt Hall and California Hall. Besides these there have been added three smaller concrete tunnels having an opening of 4 ft. x 4 ft. to carry steam pipes and cables under the permanent road recently completed and running in front of the new Library and past the Mining Building. These avoid the possibility of ever having to tear up the permanent roads in case of pipe line failures.

The method of supporting steam pipes and returns is shown in the diagram. The supports are placed at intervals of 11 feet and at suitable intervals heavy anchors imbedded in the concrete walls and sliding expansion joints are provided to care for the expansion.

The same pipe support construction is used between the power plant and the tunnel entrance across the creek. Two concrete piers about 18 feet apart and on either bank carry the uprights as shown.

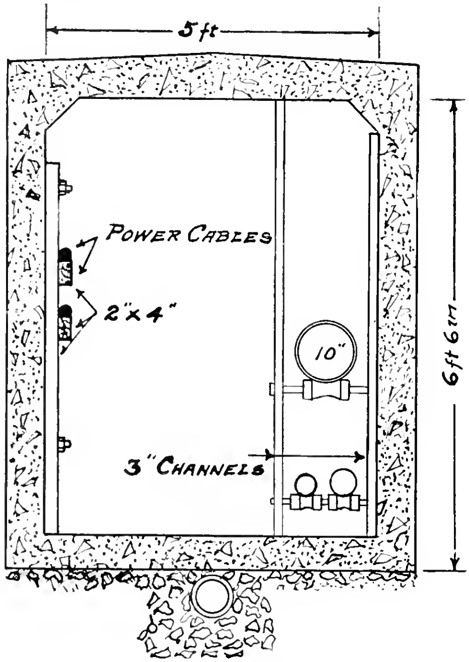
Throughout these tunnels is a full system of conduit lighting controlled by three way switches at each end of each tunnel section, the lights being spaced about 20 feet apart in incondulets.

Electric Distribution.

Up to the summer of 1909 all distribution of electric service was made from the Mechanics Building plant where the transformers, switchboards, motor generator and generators were installed. At that time the transfer was made to the power plant on the opposite side of the Campus of the above apparatus with the exception of the generator, and the equipment installed about as it stands at present, the power plant generator switchboard being combined with the others.

The character of electric distribution consists of pole line, power cabling run in iron pipe underground, and in 4-duct vitrified conduit..

This includes approximately a mile run on poles up to the Greek Theatre and on up Strawberry Canyon, supplying lights and power to the Dairy Barn,



Cross-Section View of Tunnel, Showing Clever Design of Pipe Rests.

Swimming Pool and new Hog Serum Laboratory recently completed above the Swimming Pool.

Up to a year ago the distribution was 2300 volt 2 phase, obtained from the Berkeley Lighting Co., 4000 v. power through two Scott connected 75 kw. transformers and from a two phase 2300 volt generator in the Electric Laboratory. At the time of the change from the Mechanics Building to the Power Plant and in order to continue this service the present generator was specially tapped, one phase being taken from the neutral to one 4000 volt lead, giving 2300 volts, and the other phase taken from two taps brought out from the other two windings using only 14 of the 24 coils on each winding, thus giving 2300 volts at 94 degrees phase displacement.

In the summer of 1910 all "high tension" distribution was changed over from two to three phase. This change entailed considerable work and scheming to accommodate the various motors, transformers generator, etc., to the new service, but the change was effected without any mishaps and without any serious interruptions of service. To do this, a number of two-phase induction motors had to have their windings reconnected for the three phases. This was done some time previous to the change and the motors were operated three phase from Scott connected transformers on the two-phase line.

Motor Service.

Over forty-five motors furnish power for different purposes in the various buildings, exclusive, of course, of those used for testing purposes in the laboratory equipments. The motors are single-phase, two-phase,

and three-phase induction of 110, 220 or 440 voltage. Besides these, a number of smaller motors and storage batteries are operated on the direct current line, and a number of electric furnaces and stereopticon lanterns are used in the different departments.

Lighting Service.

This service is furnished to practically every building on the grounds, and in addition, a series arc-line, over two and a half miles in length, completely encircles the campus with its thirty-six enclosed arcs and six series tungsten lamps. Current for these is furnished from a fifty lamp, 6.6 ampere General Electric arc transformer located in the Power Plant. Of the six series tungstens mentioned as part of the arc system, four of 250 watt capacity, illuminate the new Sather Gate at the Telegraph Avenue entrance as shown.

CALIFORNIA OIL INDUSTRY.

The California Oil World has compiled some interesting figures on the great oil industry in the Golden State. It is estimated that it would require an unbroken train of oil tank cars reaching from San Francisco to Chicago to haul at one load the present annual output of the California oil fields.

The present annual output of the fields of the state at 80,000,000 barrels, is at least three-eights of the entire output of the United States. Figuring the capacity of the tank cars at 300 barrels each and each forty feet in length with the usual intervening coupling space it would require, using round numbers, 267,000 cars to carry this amount and with the necessary compliments of locomotives to pull them such a huge train would reach from San Francisco to Chicago, a distance of over 2000 miles. Or it would make 8900 trains if cut up into thirty cars each.

The investment of the California oil industry represents $200,900,000. The value of Standard Oil's interest in the state is $50,000,000.

ELECTRICITY AND THE CODLING MOTH IN THE GREAT NORTHWEST.

BY AUGUST WOLF.

Electricity as an agency to destroy the codling moth is the latest innovation of modern apple orcharding in the Spokane valley, where W. M. Frost, inventor of the device, and J. C. Lawrence, a practical grower of Spokane, made what is declared to be the first demonstration of its kind in the world the evening of August 18. The test was made in a six-years' old orchard at Opportunity, Wash., where a score of second-brood moths and hundreds of green aphis were killed in a few minutes. The apparatus consists of a storage battery to charge incandescent light globes of six-candle power, which are netted with fine steel wires, coated with copper and tin, alternately. Attracted by the bright light in the tree, to which the globe is strung by a covered wire, the moth flies against the net work, completes the electric circuit and is instantly killed, the body dropping into a receptacle beneath the globe. Mr. Frost thinks that one battery to an acre of trees will keep the moths under control, thus eliminating spraying and saving many dollars for equipment and fluid. If electric light wires are extended to the orchard tracts, as they are in the Spokane valley, the expense of batteries may be saved by making direct connection and using the commercial current. The cost of covering the globes with wire nets is a small item and any electrician can do the work. Growers in various parts of eastern Washington are preparing to equip their orchards with the new pest destroyers the coming season.

GRAND PRIZE FOR ELECTRIC SAFETY LAMP.

The British government announce that, in order to encourage the production of safe and efficient types of electric lamps for miners, a colliery proprietor has placed at their disposal the sum of £1,000 ($4866.65) to be offered as a prize for the best lamp or lamps fulfilling the requirements specified below.

Mr. Charles Rhodes (a former president of the Institute of Mining Engineers) and Mr. Charles H. Merz (a member of the departmental committee on the use of electricity in mines) have consented to act as judges. The conditions of the competition are as follows:

1. The competition will be open to persons of any nationality.

2. It will be in the discretion of the judges to award the whole of the prize for the lamp which they consider to be the best, or to divide the prize, or to make no award if no lamp appears to them to be of sufficient merit.

3. Lamps must be addressed care of C. Rhodes, Esq., at the Home Office testing station, Rotherham, England, and must reach the testing station not later than December 31, 1911. A spare globe should accompany each lamp.

The requirements which should be fulfilled by any lamps submitted for competition are as follows:

1. The lamp should be of sound mechanical construction, so as to withstand rough usage.

2. The lamp should be of simple construction and easy to maintain in good order and repair.

3. The lamp should be so constructed as to render impossible the ignition of inflammable gas either within or without the lamp.

4. The lamp battery should be so constructed that any liquid which it may contain cannot be spilled when the lamp is in use, and means should be provided for dealing with any gas which may be generated by the battery.

5. The materials used and the construction should be such that metals and other parts will not be liable to deterioration by corrosion as a result of the action of the "electrolyte," etc., used in the battery.

6. The lamp should be effectively locked so that it cannot be opened without detection.

7. The lamp should be capable of giving an amount of light not less than 2 candlepower continuously for a period of not less than 10 hours.

8. The light should be well distributed outside the lamp. A movable reflector to concentrate or to shield the light may be provided.

In addition to the above requirements, regard will be paid to (a) the first cost of the lamp; (b) the cost of maintenance; (c) convenience in handling, and (d) the weight of the lamp when charged and ready for use.

PRIMER OF APPLIED THERMODYNAMICS.[1]

Introduction.

The development of the steam turbine during recent years and the many increasing applications of producer gas on the Pacific Coast have led western engineers to dig again into their long forgotten text-books and review subjects of by-gone college days long since forgotten. The subject matter of thermodynamics is not attractive or interesting, especially to young engineers. College students long since found this study so dry and lacking in interest to them that many nicknames for the study have been invented by them involving names more forceful than elegant. The study of thermodynamics or heat forces is essential, however, in gaining a thorough knowledge of the fundamental principles of the steam engine, the steam turbine, the gas engine, the air compressor and any other machine or device in which solids, liquids, or gases are used in developing or transmitting energy by heat.

By putting directly to the college student the question, why this lack of interest?, a very good reason is soon ascertained. The subject is usually given in the senior year. Three long years of study on the part of the student have brought him to his last year in college, and the course of thermodynamics greets him with long columns of integral signs and symbols. In his last year the student begins to realize that the bread-earning days are not far distant. He wants to put aside theory and get practical ideas. Toward the latter part of the senior year when the practical side arrives at last, he has but a few weeks left before graduation, and in the excitement of the closing days of his college career, he tenderly lays aside his dear thermodynamics book, hopefully trusting that kind providence will never again torture him with so many supposedly meaningless mathematical symbols for such a seemingly useless and theoretical subject.

It is the purpose of the following series of lectures to get at the applications of thermodynamics, explain them as briefly and simply as possible, and in so far as is possible accomplish all results without the use of any but the simplest mathematics. It is the opinion of the author that not only depth of the subject must be reached by the engineer, but the thorough mastering of the fundamental principles is essential. These fundamentals should be so thoroughly mastered that never again through life should the engineer have difficulty in grasping every possible application of the steam tables, adiabatic and isothermal expansion and entrophy. With this idea in view, the following series of lectures are designed and if they call forth a good healthy discussion, a more earnest desire among young engineers to seek the truth in their chosen profession, the author shall feel that his purpose has been accomplished.

First Lecture.

Heat—Temperature.

When we put our finger into a cup of warm water and then again into water formed by the melting of ice, a distinct sensation is felt in each case. Many years ago scientists and philosophers attempted to explain this sensation by assuming that a substance existed which they called "caloric," whose entrance into our bodies caused the sensation of warmth, and whose egress therefrom the sensation of cold. But heat, if a substance at all, cannot be similar to those substances with which we are familiar, for a hot body weighs no more than one which is cold. The calorists then, had to give a hitherto unknown property to their substance and maintained that "caloric" was a weightless fluid. This substance also had the property of filling the interstices of bodies and of passing between bodies over any intervening space. To illustrate, they said, caloric would fill the interstices of a body as water enters a sponge. Now, when we squeeze a sponge some of the water oozes out and wets our hands. The calorists assumed that the friction or rubbing of a body, with the hand, for instance, made the hand warm because friction was supposed to decrease the capacity of a body for holding "caloric," and as in the squeezing of the sponge, water oozes out, so caloric oozed out and made the hand feel warm. Davy, however, exploded this theory in 1799, when by rubbing two pieces of ice together, he actually caused the ice to melt. This evidently would be impossible under the caloric theory above stated, according to which friction caused capacity for caloric to be decreased. Yet here was evidenced the adverse. From time immemorial, men have considered that the force of truth is almighty, and yet how slow the human race is to overthrow an imperfect but well-established theory. For instance, so powerful was Sir Isaac Newton's grip on the scientific world that because he announced that no successful correction could ever be made for the uneven refraction of light rays in lenses, the whole world for fifty years thoroughly abandoned the idea of ever being able to use refractive telescopes, and consequently, during this period we find telescopic reflective mirrors used entirely. And so it was in the case of the theory of heat. Notwithstanding the all-powerful demonstration of Davy in 1799, it remained for Joule, nearly fifty years later to finally put forth the finishing data to forever overthrow the caloric theory and introduce the modern idea of heat. This eminent scientist constructed a machine in many respects similar to an ice-cream freezer, the essential difference being, however, that the machine was used to increase the heat in the liquid instead of cooling the same. Joule conceived the idea that heat was one form of energy. Should this be true, it should be mutually convertible. One of the easiest methods of measuring energy is the well known pile driver. Energy is definitely computed by weighing the hammer in pounds and multiplying by the distance in feet through which the weight falls. The result is foot pounds of energy. By a clever contrivance constructed somewhat on this principle, Joule measured the amount of energy absorbed in his machine and the consequent rise of temperature in the liquid. He soon established the fact that a definite number of foot-pounds of mechanical energy was equivalent to a definite number of heat units in the liquid. This experimental result is most important and is one of

[1]A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

the basic principles of modern engineering. Careful scientific measurements have proved that one British thermal unit, or B.t.u. of heat energy is equivalent to 778 foot-pounds of mechanical energy.

Heat may be communicated from one body to another in three different ways, namely: by radiation, conduction and convection.

It is a matter of common knowledge that when two bodies at different temperatures are separated by a transparent medium, such as air, or water, or glass, or ice, heat passes from the warmer to the colder irrespectively of the temperature of the intervening medium, except in so far as its transparency may in some slight degree be affected by the temperature. This process of transference from one body to another body at a distance through an intervening medium is called radiation of heat.

When two bodies are in contact, one with the other, heat is transferred from the warmer to the colder. This process is called conduction of heat. Convection is the transfer of heat caused by the rise of heated particles in a mass of liquid or gas. For instance, in the so-called "hot air" heaters the room is warmed by heated particles of air being conveyed by convection currents to various parts of the room. The transference of heat from a furnace to the boiler takes place by all these methods, radiation, convection, and conduction, while the heat is distributed through the mass of the water by convection. At present, however, the exact laws governing these methods of transfer are unknown.

One of the most striking and beautiful illustrations that can be cited from the great forces of nature in which convection currents are utilized is the non-freezing of our mountain lakes in winter, thus demonstrating the ever presence of a kind providence in protecting life, for in this case the lake trout are preserved. When the cold winter weather arrives the surface waters of our mountain lakes contract or become more dense. The surface waters thus becoming heavier sink below allowing the warmer waters to rise to the top. These in turn become cooled and sink, allowing the warmer waters again to rise. In this way convection currents are continually exerting themselves lowering the temperature of the entire lake waters. When the water is within 7.1 deg. F. of freezing solid, as if nature half repented for the crime about to be permitted, it has endowed the water with such unique physical properties that no longer does it grow more dense in cooling but on the contrary less dense, hence the convection currents are automatically stopped in time to keep the lake from freezing solid and water being a comparatively poor conductor of heat, but a thin coating of ice is formed.

Before going further into a discussion of the mechanical equivalent of heat, which, as we have seen, was first computed by Joule, it is positively necessary that we have a clear conception of the difference between "quantity" of heat and mere difference in "temperature." Let us conceive that we have before us a vessel containing 62.5 lb. of water at O deg. C. or just above freezing point and another vessel containing an equal amount of water at 100 deg. C., or just below boiling point. Conceive also that we have two pieces of lead each weighing 62.5 lb., the one at 0 deg. C. and the other at 100 deg. C. If you dip your finger into the hot water and touch the hot lead you will experience the same severe burning sensation, and yet if you mix the hot water with the cold lead and the cold water with the hot lead the remarkable result is obtained that in the former case the resultant mixture is very close to 97 deg. C., while in the latter case the mixture has but a temperature of 3 deg. C. Hence it is very evident that different bodies have different capacities for storing heat, and that "quantity of heat" and "temperature" are widely different conceptions. With the exception of hydrogen gas, water of all the physical substances, is capable of storing more heat, whereas lead is one of the poorer reservoirs of heat energy for a given rise in temperature.

From the above discussion it is readily seen that temperature is an indicator of the physical effect of heat rather than a quantitative means of heat measurement. In the strictest sense, then, the word heat is used to denote that something which the hot lead in the above illustration communicated to the cold water when the hot lead lost 97 deg. in temperature and the cold water was raised in temperature to 3 deg. C. Temperature on the other hand is a definite quality of matter, varying generally in any particular piece of matter when heat is communicated to it or taken from it, although we shall find some most important exceptions in which large quantities of heat may be added to a substance or taken therefrom without affecting the temperature in the slightest degree.

Next, then, in order that we may talk intelligently regarding "quantity of heat" and "temperature," it is necessary that we give at once the units in which we are to measure "quantity of heat" and "temperature."

In casting about for some physical substance to use in our definitions, almost any substance might have been selected, but as water is so widely distributed throughout the globe and can be secured comparatively easily in a pure state, scientists and engineers have made use of it for their unit definitions.

That amount of heat which is required to raise one pound of water from 62 deg. F. to 63 deg. F. is called one British thermal unit, or one B.t.u., and is universally used as the heat unit by American and British engineers. On the other hand, that amount of heat which is required to raise one kilogram of water from 15 deg. C. to 16 deg. C. is called one calorie, and is universally used by scientists, and is being more and more used among engineers.

We find by proper substitutions and calculations that

1 B.t.u. = O.252 Calorie.
1 Calorie = 3.97 B.t.u.

In the matter of temperature measurement three separate systems are in vogue and are the Fahrenheit, Centigrade and Reaumur. The first mentioned scale indicates the freezing point of water at 32 deg. F. and the boiling point at 212 deg. F., the second at 0 deg. C. and 100 deg. C., and the third 0 deg. R. and 80 deg. R., respectively. It is most unfortunate that the three separate scales should have attained such a hold upon the engineering and scientific world that

we should thus be compelled to be able to readily convert any one scale into units of the other.

The Fahrenheit scale although more cumbersome than the Centigrade is used almost entirely in engineering practice, while the Centigrade is used in scientific works and by engineers on the continent. The Reaumur is used in Russia and in distilleries and breweries.

In Fig. 1 will be found a diagrammatic representation of the three scales and their respective numerical

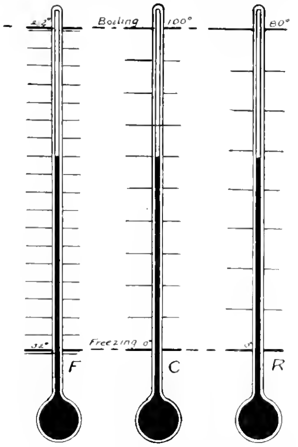


Fig. 1.

values at the two common points of calibration, namely: the freezing and boiling points of water. For strictly accurate transformation of the one to the other, however, we should deduce exact equations, so that any temperature on one scale can be quickly and accurately computed on the other. We shall, then proceed to deduce definite algebraic relationships of the one with the other.

Among the ancient Greeks, Euclid proved that if we have a triangle as shown in Fig. 2 with a line CE

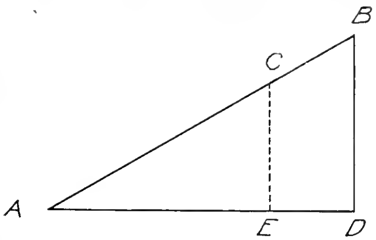


Fig 2.

drawn parallel to BD then the length CE would be to BD as AE is to AD or algebraically speaking:

$$\frac{AE}{AD} = \frac{CE}{BD}$$

Turning our attention now to Fig. 3 we have the same figure, only a little bit disguised.

Let us suppose we have two points A and B, fixed in the plane of the paper and that these points measure y_1 and y_2 units from the line X X and x_1

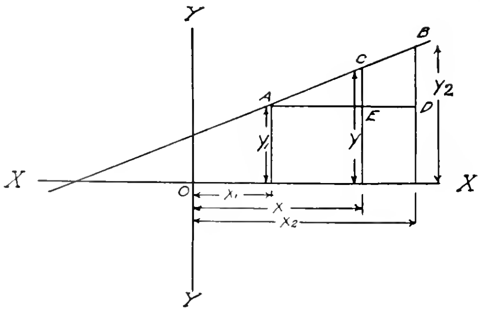


Fig. 3

and x_2 units from the line Y Y. Since these points are permanently fixed, the line A C B is permanently fixed, as two fixed points determine a line. Now let us take any point on the line A B such as C. Evidently, at any given position it will measure y units from the line X X, and x units from the line Y Y, and consequently under any given definite conditions its position is fixed. Looking at the figure we have

$$CE = y - y_1 \quad BD = y_2 - y_1$$
$$AE = x - x_1 \quad AD = x_2 - x_1$$

or substituting, we have

$$\frac{AE}{AD} = \frac{CE}{BD}, \text{ or } \frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

Returning now to our temperature scales let us derive a relationship between the Fahrenheit and Centigrade scales. We have two definite given conditions.

At freezing point of water $x_1 = 32$ deg. on Fahrenheit, which corresponds to $y_1 = 0$ deg. on Centigrade.

Also at boiling point of water $x_2 = 212$ deg. Fahrenheit, which corresponds to $y_2 = 100$ deg. on Centigrade. And in general let $x = F$ on the Fahrenheit scale correspond to $y = C$ on the Centigrade scale. Substituting we have

$$\frac{x - x_1}{x_2 - x_1} = \frac{y - y_1}{y_2 - y_1} \text{ or } \frac{F - 32}{212 - 32} = \frac{C - O}{100 - 0}$$

or $100\ F - 3200 = 180\ C$.

$$F = 9/5\ C + 32 \quad \ldots\ldots\ldots\ldots\ldots (1)$$

The student can similarly by proper substitutions derive a relationship between each of the other two possible combinations and find

$$C = 5/4\ R \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$
$$R = 4/9\ (F - 32) \quad \ldots\ldots\ldots\ldots (3)$$

A simple but extremely accurate graphical method of computing corresponding numbers on the three temperature scales is very easily accomplished as follows: Take an ordinary piece of plotting paper as shown in Fig. 4. Lay off Fahrenheit units on the lower horizontal line, allowing 2 units per degree or 10 units for 20° F. Along the left hand vertical column lay off the centigrade scale with one unit per degree centigrade. If ordinary temperatures are to be measured, it is convenient to begin in the lower left hand corner with —40 as both readings of Fahrenheit and Centigrade scales

are numerically equal at this point. Next plat the boiling point of 212° F corresponding to 100° C and draw the line and instantly relationships are obtained for any other corresponding temperatures. The Reaumur scale is next very easily added on the right hand vertical column. Begin its zero point corresponding to the zero horizontal line on the centigrade scale and its 80 degree point corresponding to the 100 degree point on the centigrade scale. Each series of 10 units on the paper will be found to correspond to 10 degrees Reaumur scale measurement. Smaller units are quickly interpolated and added to the scale. Should high temperatures be necessary for transformation any two points can be chosen instead of the freezing and boiling points in order to draw the straight line obtained above and the same accurate result obtained over the new range of temperature desired.

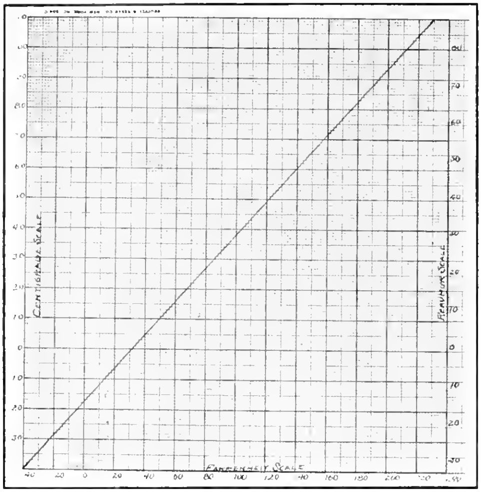


Fig. 4.

The following are a few useful temperatures corresponding to the Fahrenheit scale and can be easily checked from the formulas given above.

TABLE I.

COMPARISON OF THERMOMETER SCALES.

	Fahrenheit.	Centigrade.	Reaumur.
Absolute zero	—460.66	—273.70	—218.96
	0.	—17.77	—14.22
	10.	—12.23	—9.77
	20.	—6.67	—5.33
	30.	—1.11	—0.88
Freezing point	32.	0.	0
Maximum density of water	39.1	3.94	3.15
	50.	10.	8.
	75.	23.89	19.11
	100.	37.78	30.22
	200.	93.34	74.66
Boiling point	212.	100.	80.
	250.	121.11	96.88
	300.	148.89	119.11
	350.	176.67	141.33

THERMOTWISTERS.

1. The normal temperature of the human body is 98.6° F. Express in Centigrade and Reaumur degrees.

2. Compute by equations given above at what temperature the Fahrenheit and Centigrade scales read alike. Similarly for the Fahrenheit and Reaumur scales.

3. Given that $y = mx + b$ is an equation which represents in general the three thermometer scales in which y or x can be either F, C, or R. Compute the two constants m and b by substituting corresponding values on scales for boiling and freezing point of water and thus deduce for yourself the three equations above.

ENGINEERING OPPORTUNITIES WITH FOREIGN NEIGHBORS.

Our immediate neighbors to the north and south are presenting ever broadening opportunities for engineering enterprise. The unexcelled increase in exports to them from our Pacific Coast cities give a very striking illustration. Let us take Chile as an example.

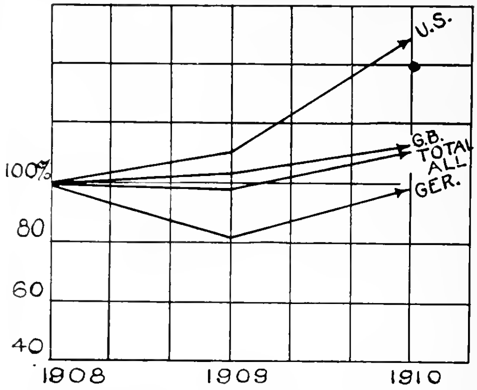


Fig. 1. Steepness of Individual Line Represents Increase of Imports Into Chile for Each Particular Country Shown.

The United States has been making substantial gains in nearly every division, with exceptionally large increases for mineral products, oils, coal, and machinery. The heavy increase in mineral products is principally in steel, bars, rods, plates, structural shapes and angles, while under the head of oils and coal, the greater gains were in kerosene, paints, oils, and

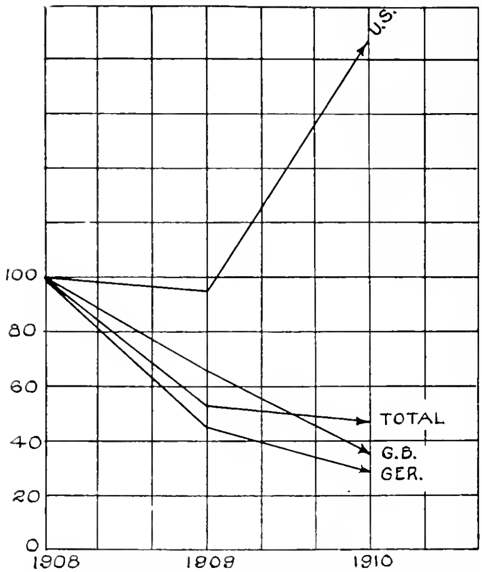


Fig. 2. Steepness of Individual Line Represents Increase of Oil Imports Into Chile for Each Particular Country Shown.

crude petroleum for fuel. The imports of American machinery show a substantial gain, while the United Kingdom and Germany show a decrease.

The following table shows the total imports, by classes, into Chile for the past three years and the share of the United States, United Kingdom, Germany, and France in that trade:

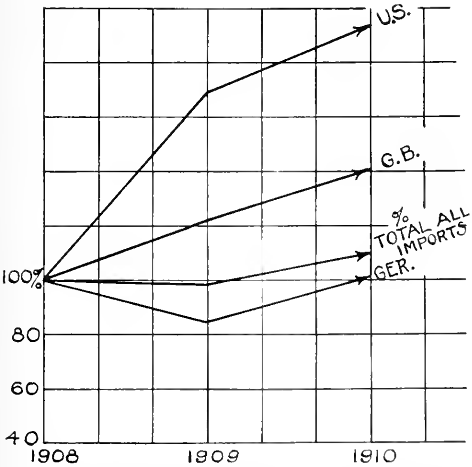


Fig. 3. Steepness of Individual Line Represents Increase of Machinery Into Chile for Each Particular Country Shown.

Mineral products cover iron and steel bars, plates, rods, cement, building hardware, etc., and vegetable products include fruits, grains, lumber, tobacco, etc.

Other countries participating in the imports into Chile to any degree were: Argentina, $5,477,808, of which $5,242,138 were animal products; Peru, $5,445,989, made up principally of vegetable products and oils and coal; India, $4,018,250, of which $3,671,269 were textiles; Italy, $3,227,853; Australia, $2,720,656; Belgium, $2,464,941; Spain, $1,349,700; all other countries, $2,904,644.

Several hydroelectric power plants are being constructed, principally by German interests. So far as known there is but one plant in the country owned by American interests, and that is connected with the Braden Copper Co. near Rancagua, Chile.

German interests control a large proportion of the electrical plants of the country and are reaching out for the most available sites for hydroelectric plants. A German company secured a concession last year for the location of a water power plant on the Aconcague River above Valparaiso with a view to supplying power and light to the region above and about this city. They so dominate this business that it is difficult to introduce anything but German electrical machinery and supplies. It will take some hard work to get back what American interests have let slip from them in this line, and it would be well for American manufacturers in other lines to take notice and see that other interests are not handicapped in a similar way, for German manufacturers are after business in Chile in earnest and every possible effort is made to capture the whole trade.

A careful analysis of the consular report above gives some interesting notes, however, and shows that at least our American engineers are wideawake to the growing opportunities on the Pacific. Oil and machinery represent typical engineering products. Below is a table showing the relative increase of American influence in these matters. Figs. 1, 2 and 3 are interesting. The steepness of each curve represents the rate of increase of each country in the commerce of Chile for the past three years. In every case American influence is seen to be rapidly gaining. In fact gaining at such a rapid rate that before many years the predominating English and German influences must give way.

Class.	Year.	Total.	United States	United Kingdom.	Germany.	France
Animal products	1908	$6,786,839	$545,312	$741,848	$685,020	$489,184
	1909	10,065,394	431,261	678,632	738,969	776,459
	1910	9,272,578	568,771	753,683	689,618	943,142
Vegetable products	1908	8,510,045	1,212,894	1,654,475	1,570,225	302,939
	1909	10,508,948	1,299,001	1,493,931	1,704,323	[illegible]
	1910	11,797,492	1,318,763	1,676,703	1,911,614	449,857
Mineral products	1908	17,020,090	822,594	6,456,157	6,396,493	556,179
	1909	16,845,468	1,495,919	6,185,639	6,365,454	780,878
	1910	18,822,566	2,431,407	5,962,177	7,507,759	872,036
Textiles	1908	20,407,329	531,273	8,208,927	5,739,650	1,507,694
	1909	23,090,729	744,498	10,412,753	5,512,716	2,214,088
	1910	29,114,560	817,003	12,156,918	7,486,407	22,637,177
Oils, coal, etc.	1908	16,990,077	1,961,432	5,949,173	1,013,519	18,795
	1909	16,532,359	3,332,720	7,365,206	864,816	34,837
	1910	18,777,322	4,147,655	8,691,669	1,037,557	78,243
Paper, etc.	1908	2,808,331	796,036	349,563	1,275,474	110,307
	1909	2,537,925	485,079	311,778	1,352,571	118,615
	1910	3,354,888	769,072	407,458	1,745,651	118,991
Wines and liquors	1908	1,883,792	13,185	467,781	265,279	540,985
	1909	1,956,006	8,236	466,306	234,961	613,728
	1910	2,582,401	18,222	596,567	318,751	772,756
Chemicals, perfumery, etc.	1908	1,983,176	207,722	420,964	887,006	358,547
	1909	2,016,405	232,282	479,511	817,317	353,295
	1910	2,325,534	298,628	613,639	847,966	391,625
Machinery	1908	19,336,529	2,502,349	6,014,590	9,068,898	283,234
	1909	10,174,882	1,396,477	3,987,823	4,123,729	196,098
	1910	9,508,683	2,724,965	2,739,225	3,266,020	310,967
Arms, etc.	1908	633,148	62,408	226,818	285,081	13,212
	1909	828,316	96,104	292,488	352,253	10,685
	1910	1,598,489	215,470	504,800	762,911	27,021
All other	1908	813,604	42,084	140,513	369,139	144,769
	1909	842,967	79,507	168,679	369,899	161,849
	1910	1,472,675	59,818	237,734	691,787	406,114
Totals	1908	97,202,960	8,697,289	30,630,809	27,555,784	4,355,849
	1909	95,399,399	9,601,084	31,842,746	22,436,041	5,663,495
	1910	108,627,188	13,369,774	34,340,573	26,296,071	7,010,929

TABLE I.

	Year.	Total. Per cent Increase.	U. S. A. Per cent Increase.	Gt. Britain. Per cent Increase.	Germany. Per cent. Increase.
All imports	1908	100	100	100	100
	1909	11.8*	11.1	1.	18.6*
	1910	13.9	37.7	7.9	17.2
Machinery	1908	100	100	100	100
	1909	17.4*	5.0*	33.8*	51.5*
	1910	6.5*	95.2	31.3*	20.8*
Oils, coal, etc.	1908	100	100	100	100
	1909	2.7*	70	23.8	14.7*
	1910	13.6	24.5	18.0	16.7

* Indicates decrease in percentage.

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CONTENTS

Crude Petroleum

The last decade has witnessed such startling advances in the use of crude petroleum due to its practically unlimited natural supply on the coast we can hardly realize what the immediate future may still have in store for this great industry. Recent unofficial reports show that the production during the first six months of the present year was beyond the 37,000,000 barrel mark. No less interesting is the compilation of statistics which show, also, that in spite of the low market price of oil, dividends for July amounted to the total of $693,038.56. It is also stated that in addition to this amount there are a number of large producers that paid dividends, but declined to make public announcement.

Last season witnessed one of the greatest forest fires in the history of our national forests. Careful investigation has shown that while some of these fires had their incipiency in the careless handling of campfires and the like, by far the greater portion were started by sparks from the coal and wood used in the heavy railroad traffic over the mountain passes. Further investigation on the part of the forestry officials has led them to the conclusion that the use of oil in locomotives is practically the only means of safe-guarding our national forests during an exceedingly dry season such as last year. The great transcontinental railroads of the northwest are giving the subject of fuel and power supply the deepest thought and consideration. It will not be at all surprising if within the near future a remarkable change will be undertaken, namely the electrification of the mountain passes and tunnels where practicable and when impracticable the entire use of oil as a fuel.

Much study and investigation is still being concentrated on the use of internal combustion engines. The great saving of this form of power development in Marine engineering is unlimited. The oils of the coast are even now being shipped by sea to all parts of the globe. The Panama canal and the still further development of internally fired engines for marine service certainly give a golden tinge to the great oil industry of the coast.

Primer of Applied Thermodynamics

The theoretical side of engineering is difficult to grasp. Each year there are dropped from our technical schools hundreds of engineering students who do not and seemingly cannot grasp the great fundamental principles. If this is true of those attempting to gain knowledge where every facility is offered, how difficult it must be for that great class of young men who, though longing for an opportunity to gain knowledge, are through misfortune unable to attend our great technical schools.

The study of Thermodynamics is imperative if one desires to master the fundamentals of the steam engine, the gas engine, the air compressor, and the

many other practical applications in which the transference of heat quantities is made use of.

The subject as usually presented, requires the use of the calculus. This is undoubtedly necessary for the fullest investigation. But the young man denied the opportunities of higher education may accomplish much without it, for many engineers testify that they have absorbed more real theory and practical knowledge from the steam tables and the excellent explanatory data given in the trade publications than from the severe mathematical treatises on the subject.

Elsewhere in these columns will be found the beginning of a course of lectures entitled, A Primer on Thermodynamics. The subject will be attacked from the practical man's point of view entirely. The use of calculus will be avoided wherever possible. The order of procedure will not be the same as usually undertaken. The order is one, however, that has been tried four years in the class room in one of our State Universities, and the testimony of young engineers now out in the field of struggle who received the course in the order that will be followed in this series of lectures, strengthens the author in his belief that, for western engineers at least, it is superior.

As set forth in the title of this series, only a beginning can be accomplished in this great study. About us, we see thousands of young engineers yearning for better and higher things. We see others in the allied professions who would like to grasp the fundamentals of Thermodynamics but have not the time to go to its depths, even though thoroughly trained in the use of higher mathematics. It is these two classes the Journal hopes to reach. The Journal feels that its mission is to be of some valuable assistance in spreading the truth in engineering. If this series of articles accomplishes this result in the slightest degree—yes—even if it succeeds in one single instance in helping some worthy young man to better himself in life, to feel a deeper, broader responsibility in his profession, we shall feel our efforts have not been in vain.

Engineering and Foreign Neighbors

The country of the Aztecs and the country of the ucas as set forth in the conquest of Mexico and the conquest of Peru have ever held the American boy spell-bound with the gorgeous descriptions of these ancient civilizations. The everliving memory of Cortez and Pizarro resplendent in their victorious conquests has done much in awakening the constructive imagination of the American engineer in embryo. The strife and turmoil of our near neighbors to the south have had a strong influence, however, in killing the immediate application of many of these constructive dreams. So long as the question of political supremacy is decided by the sword, so long will the true commercial greatness of a country be dormant.

Our own country has been undergoing such a tremendous internal growth in recent years, its citizens have hardly had time to consider the engineering conquests in the sister republics to the south even now awaiting the triumphal entry of our engineers.

Long since have our American engineers realized and taken advantage of the opportunities in western Canada and to a large extent in Mexico. By casual inquiries in British Columbia and Mexico in regard to the designers and constructors of the present great electrical development in those countries, it will be found that they are engineers from the United States. It is flattering to the West to know, too, that Western engineers have almost entirely monopolized this work.

A new and almost unlimited field of opportunity now presents itself. The South American republics are just awakening to a sense of their commercial importance. Strife and discord are being laid aside, and the sword transformed into the plough-share, thereby accomplishing wonderful results.

Especially is this awakening being felt in the countries bordering on the Pacific. The nearness of the completion of the Panama Canal project has set the commercial activities of these countries fairly a-whirl.

Eleswhere in these columns will be found a consular report of the commercial activity in Chile, which is a typical example of the activity shown in the other Latin-American countries of the Pacific. It is seen that in the year 1908 an immense impetus was here received in the way of imports of machinery and the like, which immediately followed the realization of the Panama Canal opportunities for Chile. In the United States our engineers were so engrossed with gigantic internal development that as in all previous years, this foreign neighbor was almost overlooked.

What was the result?

Wide-awake German enterprise corralled almost the entire machinery import. The wonderful hydroelectric prospects were gobbled up and a firm hold secured on the commercial future of the country. Although the total imports into this country in the way of machinery have been less in the succeeding two years, yet it is surprising how wide-awake American enterprise has became to opportunities lost and efforts to secure now what should have been ours from the first.

In the article referred to are shown charts indicating the percentage of increase or decrease of imports in Chile each year since 1908. The steepness of the line for the particular case shown indicates the proportionate increase or decrease. The line for machinery imported from America shows a wonderful vitality. In every instance the American increase is far superior to our foreign competitors.

Let us awake to our natural birth right. Western engineers with headquarters in our Pacific coast cities should never again allow a foreign engineering foothold in the Western Hemisphere. A hundred years ago our forefathers sprung the Monroe Doctrine as to Ameican politics. Let us extend the Doctrine to engineering enterprise. The conquest this time will not come by threats of forcing to arms, however, but by keen, alert, American brains and figures. Let us oil up the "slide-rules."

PERSONALS.

A. C. Balch, of the Pacific Light and Power Company of Los Angeles, was a recent San Francisco visitor.

R. S Buck, of Sanderson & Porter, of New York, is in the Pacific Northwest on engineering business.

C. C. Hillis, Pacific Coast Manager for the Electric Appliance Co., has returned from the Electrical Jobbers' Convention at Saratoga, N. Y.

E. V. D. Johnson, general manager of the Northern California Power Company, has returned to Redding after visiting the company's San Francisco office.

C. O. Poole, of Manifold & Poole, arrived at San Francisco from Los Angeles last Thursday on important electrical engineering business connected with hydroelectric power transmissions.

Ben D. Moses has accepted the position of instructor in Mechanical Engineering at the University of California. Mr. Moses will assist Jos. LeConte, hydraulic expert, in his University work.

Sydney Sprout, electrical engineer for the Siskiyou Light and Power Company, which has just purchased the Rogue River Electric Power Companys holdings in Southern Oregon, has returned to the scene of operations in Siskiyou County after spending several days at his San Francisco office.

Robert Mather of New York, who is chairman of the board of directors of the Westinghouse Electric and Manufacturing Company, arrived at San Francisco last week in his private car on a tour of the Pacific Coast. He will inspect his mining properties in Trinity County before leaving California.

Delos A. Chappell of Denver, who is at the head of the Nevada-California Power Company, and is interested in the Pacific Power Company, spent the past week at San Francisco conferring with his engineers in connection with the proposed 250 mile extension of the former company's transmission lines into Southern California.

W. McGlashan has assumed charge of the new office of the water division of the United States Geological Survey at San Francisco, which has taken the place of the two offices formerly maintained at Sacramento and Los Angeles. Preparations are being made for surveys of the water supply in all of the streams in the Sacramento Valley.

Arthur P. Davis, chief engineer of the U. S. Reclamation Service, J. R. Freeman, consulting hydraulic engineer, F. G. Baum, consulting engineer and J. H. Wise, assistant general manager of the Pacific Gas & Electric Co., recently made a trip to the mammoth Spaulding damsite of the Pacific Gas & Electric Co. A careful study of the foundation for the 275 ft. concrete dam is being made possible by means of diamond drills.

Gano Dunn, who for some years has been first vice-president, chief-engineer and a director of the Crocker-Wheeler Company, has resigned from that company in order to accept an important engineering and executive position. Mr. Dunn will sail shortly for Europe to attend, as President of the American Institute of Electrical Engineers, the meeting during the Turin Exposition of the International Electrotechnical Commission, to be held on September 7th, 8th and 9th, and also the following meeting of the International Electrical Congress.

S. B. Charters, professor of electrical engineering at Stanford University, has been elected chairman of the San Francisco Section of the American Institute of Electrical Engineers. The other members of the executive committee are: H. A. Lardner, Pacific Coast manager for J. G. White & Co.; F. F. Barbour, assistant to president Pacific Gas & Electric Co., H. W. Crozier of the Pacific Coast office of Sanderson & Porter and A. H. Halloran, managing editor of the Journal of Electricity, Power and Gas, succeeding W. A. Hillebrand who has resigned to become professor of electrical engineering at the University of Oregon, Allen G. Jones is secretary.

ELECTRICAL CONTRACTORS' NOTES.

Wm. Turner, an electrical contractor of San Francisco, recently spent a few days at Sacramento looking after his interests there.

The Pacific Fire Extinguisher Company have been awarded the wiring on the Bankers' Investment Building; contract price, $8500.

Frank Somers of the Century Electric Company of San Jose was at San Francisco last week with the Fraternal Order of Eagles in convention.

The San Francisco Electrical Works, H. P. Thayer, manager, is finishing up a large contract for wiring and electric motor installation at the D. Ghiradelli Company's chocolate factory on North Point street.

The Metropolitan Electrical Construction Company has just completed a big wiring contract on the New John Cort Theater on Ellis street. This firm is also doing the wiring for the new Alcazar Theater on O'Farrell street and the new Pantages Theater on Market street. C. S. Phillips acted as illuminating engineer in designing the lighting installations.

Arthur Uglow, who was formerly connected with the Savoy Theater, is chief electrician at the new John Cort Theater on Ellis street, which will have its opening Saturday, September 2. The electrical illumination of the house is on a magnificent scale, the indirect system of incandescent lighting having been adopted. Nearly six thousand lamps are used, there being more than one thousand concealed lights on the front of the building.

TRADE NOTES.

The General Electric Company has sold to the Pacific Gas and Electric Company for use with its additional Curtis turbine generating set, one C. C. 4, 125 kw., 2400 r.p.m., 125 v., shunt wound Curtis turbine exciter unit. To the Yuba Construction Company the following gold dredge equipment has been sold: One 200 h.p. dredging motor; one 30 h.p. winch motor; one 100 h.p., one 50 h.p. and one 30 h.p. pump motor; one 40 h.p. screen motor; one 50 h.p. stacker motor; one 25 h.p. monitor pumping motor; one 2 h.p. tool motor; two 5 k.v.a. transformers, and a switchboard.

Hunt, Mirk & Co. have sold to the Pacific Gas and Electric Company a Worthington surface condenser equipment of 25,000 square feet, with a 40,000 gallon Byron Jackson centrifugal circulating pump to be direct connected; American Ball angle compound engine for use in connection with the 12,000 kw. Curtis turbine generating set that is to be installed in Station C at Oakland. Also, to the San Francisco Gas and Electric Company, for installation at Station A, San Francisco, a 25,000 square-foot Worthington surface condenser for use with the new 15,000 kw. Curtis turbine which is being built.

Work is to be begun within a month on the new assembling plant of the Westinghouse Company in Emeryville, at Park avenue and Halleck street. S. G. Down, Pacific Coast engineer for the company, now in charge of the San Francisco office at the Pacific Building, is awaiting the final detailed plans and orders to begin work. It is expected that more than 100 electricians will be employed in the new shops, where all classes of electrical goods manufactured by the Westinghouse Company will be manufactured for market. This is to be the distributing point for the Western territory and the Orient. Twenty electrical experts are being sent out from the home plant at Pittsburg to superintend the establishment of the new plant.

INDUSTRIAL

14000 K.V.A. TRANSFORMERS.

About two years ago the General Electric Company shipped to the Great Western Power Company, a number of 10,000 k.v.a. transformers, these units being the largest manufactured at that time. Since the installation of these units, other operating companies have followed the example set by the Great Western Power Company and, at the present time, quite a number of transformers of this exceptionally large capacity are in operation at various places.

Still larger units and, in fact, the largest transformers by far ever constructed, have recently been shipped by the General Electric Company to the Shawinigan Power Company,

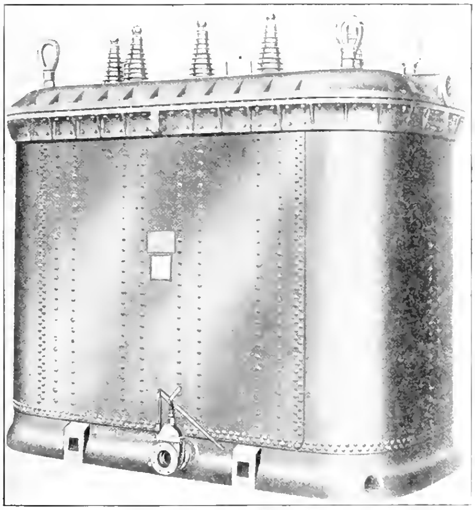


Fig. 1. 14,000 k.v.a. Transformer for Shawinigan Power Company.

at Shawinigan Falls, Canada. This shipment included four three-phase water cooled units designed for operation at a frequency of 60 cycles, two of them having a normal load capacity of 14,000 k.v.a. and the remaining two of 12,500 k.v.a. The 14,000 k.v.a. transformers will step the potential up from 6600 volts to approximately 100,000 volts for long distance transmission All four transformers have the same overall dimensions, occupying approximately 23 ft. by 8½ ft. floor space and being 18 ft. from the floor to the top of the

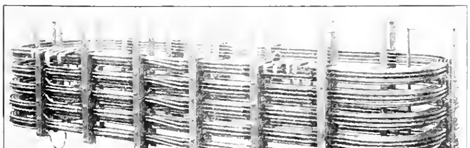


Fig. 2. Cooling Coils of 14,000 k.v.a. Transformer.

high tension terminals. The construction is exceedingly substantial, practically the only castings are the base and cover, the walls of the tank being made of steel plate ⅜ in. thick. On account of the great weights necessarily dealt with, the supporting frame work of the coils and core is built up of heavy "I" beams, the general appearance of the frames closely resembling the construction used in large locomotive frame work.

These transformers were designed to withstand a high potential test of 270,000 volts from the high tension winding to all other parts. Oil filled entrance leads are employed and these also were subjected to this high tension test. Although the striking distance of this test voltage in clear air is nearly 2½ ft., it is noteworthy that, when applied to these transformers after dark and with all lights turned out, no corona was visible.

There appears to be no practical limit in the design of transmission transformers either from the standpoint of capacity or voltage, as both of these conditions are limited by other features,- the transmission lines being the limit for potential and the transportation facilities for the size of the units.

TRADE NOTES.

The Trumbull Electric Manufacturing Co. has issued the August number of Trumbull Cheer. The pamphlet is replete with witty sayings, interspersed with Trumbull Cutouts and other apparatus handled by the company.

Proceedings of the second annual convention of H. M. Byllesby & Co. and affiliated companies have recently been published. The publication is replete with data regarding this energetic company and many interesting technical papers read at the convention are printed. The book contains over four hundred pages.

The Federal Telegraph Company, employing the Poulsen system, has been handling commercial business on the Pacific Coast since June 26th of this year between San Francisco, Los Angeles, San Diego, Stockton and Sacramento. Commencing with the first of September their service has been extended to Portland, Oregon and El Paso and Fort Worth, Texas, with immediate plans for reaching Kansas City. They are handling short messages, day and night letters at two-thirds the price charged by the regular telegraph companies.

Thirty-one members of The Buckeye Electric Company's sales force held their annual sales conference at Association Island during the week of August 14th. Accompanying the party were the wives of six of the men and a number of guests closely associated with the Buckeye organization. In summing up the last year's business and outlining future policies, L. P. Sawyer, general manager of the company, expressed complete confidence in the business outlook and mapped out a program of aggressive development for the coming season.

The Crocker-Wheeler Company of Ampere, N. J. announces the opening of a San Francisco office in the First National Bank Building, which will be ready for business on September 1st, 1911. This company is well known as a builder of high grade electrical machinery of up-to-date design, and has been engaged in the manufacture of electric power machinery for twenty-three years The company ranks as one of the largest electrical manufactures in the country and claims to be absolutely independent of any other concern.

Their Eastern business has, until recently, kept their plant fully employed, but now, having increased their facilities they are looking for a larger share of the Coast business.

The San Francisco office will carry a full stock of standard motors, generators and transformers, and requests that they be given opportunity to submit bids on proposed installations.

NEWS NOTES

FINANCIAL.

EXETER, CAL.—An ordinance has been passed calling an election on August 31 to vote $42,000 bonds for building a water system.

ALBANY, ORE.—The Continental Jewell Filtration Co. of New York has received contract for the installation of a filtration plant for the Oregon Power Co., at a cost of about $30,000. The new plant will be housed in a concrete structure, and adjacent to the new electrical power station.

ROSEBURG, ORE.—The Oregon Gas and Electric Co., operating in Oregon, California and other Western states, has filed trust deed and mortgages to secure a bond issue of $660,000, executed in favor of the Anglo-California Trust Co. of San Francisco. The company is installing a $60,000 plant in Roseburg.

OAKDALE, CAL.—The best bid for both the sewer and waterworks bonds was made by E. Rodden for the First National Bank and the sale of the bonds on this bid was authorized. Mr. Rodden's bid was a premium of $185 on the entire $20,000 of sewer bonds, and a premium of $51 on $25,000 of waterworks bonds. The other bid on the bonds was from the California Life Insurance Co. who offered to take $8,000 of the sewer and $10,000 of the waterworks bonds at par.

ORANGE, CAL.—The Chamber of Commerce has carried a resolution through recommending that a bond election be called for improving the city water system which the water superintendent estimates will cost about $48,000. Fire company officers estimate that $5,000 is needed to properly equip the fire department for effective fire fighting, including new hose, automobile fire truck and chemical engine. A petition calling for the bond election will be presented to the city trustees at the next meeting. It is believed that speedy action will be taken.

SAN FRANCISCO, CAL.—D. H. Foote, secretary of the Pacific Gas & Electric Company, has announced that the stockholders of the company will be called upon to vote at a special meeting October 23d on the increase of the bonded indebtedness of the company to $150,000,000, with a parallel increase in the capitalization of $160,000,000, all of the proposed increase to be common stock. About $60,000,000 of the bonds will be used for refunding the company's present issues, the balance being available for development work during the next ten years. Among the projects which will call for heavy expenditures is the extension of the South Yuba irrigation and power systems in Nevada and Placer counties, where $10,000,000 will be spent in accordance with plans now being passed upon by Maj. Arthur P. Davis and J. R. Freeman, who have recently been called in consultation on this subject. A million and half is being spent in the installation of steam power to supplement the hydroelectric system. Extensions now being made to the mains of the company's gas system in San Francisco will require the expenditure of approximately another million.

INCORPORATIONS.

MILES CITY, MONT.—The Miles City & Eladaka Telephone Co. has filed incorporation articles increasing its capital stock from $6,000 to $25,000.

SANTA ANA, CAL.—The El Modena Mutual Water Co. has incorporated with a capital stock of $43,000 and is to distribute water on 430 acres of land at El Modena. The incorporators are F. E. and E. V. Crawford of Pasadena and G. B. Lancaster of El Modena.

SACRAMENTO, CAL.—The North Sacramento Light and Water Co. has filed articles of incorporation with a capital stock of $50,000. The directors of the firm are: Marshall Diggs, Ray C. Waring and M. N. Williamson, of Sacramento; D. W. Johnston, of Los Gatos; G. A. Richardson, of Placerville; Charles E. Hollister and James T. Elliott, of Courtland.

LOS ANGELES, CAL.—The Malibu Tidewater Railway has been incorporated with $800,000 capital stock and with M. K. Rindge at its head. This company will operate between Santa Monica and Oxnard but it is planned to build extensions as soon as right of way can be secured. The directors are M. K. Rindgo at its head. This company will operate between Rindgo. N. D. Darlington, chief engineer, will have charge of the surveying and construction work.

ILLUMINATION.

OLYMPIA, WASH.—The J. C. Corbin Co. has been awarded the contract for the erection of a power plant for the Veterans' Home at Port Orchard.

WALLA WALLA, WASH.—The Pacific Power & Light Co. has been awarded the contract for furnishing power and light to this place for a period of ten years.

BURNS, ORE.—James D. Fellows has been granted a 25 year electric light franchise and will leave in a few days to purchase the necessary machinery for a high class plant.

COLTON, CAL.—G. W. Grow, superintendent and E. S. Bryant, Engineer of the Southern California Gas Company have petitioned the City Trustees for a franchise through Colton.

FORT FLAGLER, WASH.—W. E. Chase Engineering Co., of Spokane, Wash., will install an electric lighting system for the sum of $29,000. The bids for the work were opened June 15.

KLAMATH FALLS, ORE.—The Pelican Bay Lumber Co. will require about 800 lights in its new mill and will install a plant and have it in readiness for operation when the mill is ready to begin work.

STITES, IDAHO—D. E. Frank, manager of the Kooskia Milling and Power Co. has asked the council for a franchise for furnishing light and power to the town by stringing wires from the generating plant at the mill in Kooskia.

STOCKTON, CAL.—That Stockton is soon to be provided with an underground conduit lighting system, with electroliers throughout the business district, was indicated when Councilman Brisco's resolution to call for sealed proposals for the furnishing of the system was unanimously carried.

TRANSMISSION.

PORTLAND, ORE.—The Beaumont Land Co. has been granted a permit to construct an electric line in this district.

OGDEN, UTAH—The Davis & Weber Counties Canal Co. will soon begin the construction of a power plant south of the city, near Riverdale, for generation of about 5400 electric horsepower.

PORTLAND, ORE.—The Mt. Hood R. & P. Co. has completed plans for the $45,000, two story, reinforced concrete, terminal station on the O. W. R. & N. tracks near Williams avenue; three electric generators will be installed.

BELLINGHAM, WASH.—A contract has been entered into between the Western Canada Power Co. and the local company whereby 6500 h.p. will be imported before the first of the year. The Stone & Webster power lines will connect with the Canadian company lines at Sumas and from the boundary it will be brought to this city.

ELY, NEV.—An electric power plant is soon to be erected on Cleve Creek by the Telluride Power Co., according to plans made public by representatives of the company who have been in Ely for the past several days. It is estimated that it will develop more than 3000 h.p. The plant will be used in furnishing electric light and power to Ely and surrounding camps.

OLYMPIA, WASH.—L. B. Faulkner, manager of the Olympia Light and Power Co. has closed a deal for a right of way for the transmission line from the new reservoir at Lawrence lake to this city. The new power project will cost about $300,000. The reservoir to be put in will cost $30,000. When completed power will be supplied to the smaller towns and cities surrounding Olympia.

OAKLAND, CAL.—With their objective point as Oakland and with an ultimate hope of reaching San Jose and then coming up the peninsula via Palo Alto to San Francisco, the Blue Lakes Power & Light Company, a new corporation with general offices in Sacramento, is now laying a line parallel to that of the Bay Cities Power Co. across the hills from Lake County. At the end of 84th avenue, Elmhurst, the new line will branch off and enter San Leandro via Estudillo avenue or Juanita avenue. Norman Harcourt, chief engineer in charge of the local survey party, consisting of seven men imported from the East and who are stopping at the Crellin Hotel, said last evening that the new line would be ready to serve power to the people by December.

TRANSPORTATION.

SAN LUIS OBISPO, CAL.—A franchise has been awarded Walter Gould Lincoln for a street railway in this city.

ESTACADA, ORE.—The power plant of the P. R. L. & P. Co. was visited by a fire which caused the destruction of the engine, which will require a new one to replace the one destroyed.

PHOENIX, ARIZ.—Application has been made to the City Council by the Salt River Valley Electric Co. for a franchise to construct an electric railway through certain streets of Phoenix for a period of twenty-five years.

SAN FRANCISCO, CAL.—An order has been placed by the Oakland and Antioch Railway with the Westinghouse company for an equipment of electric cars. It is understood that the contract price approximates nearly a quarter of a million dollars. The cars are to be of the combination type to carry express as well as passengers, and will operate under 600 volts and have Pantagraph trolleys.

WALNUT CREEK, CAL.—Actual work on the proposed scenic road up the slopes of Mount Diablo has been started, a party of engineers and surveyors from Oakland appearing on the scene with maps and charts. The route laid out is up Walker Canyon. A trail has been blazed all the way to the summit, and this will be followed by the laying out of the road. This road will be completed long before 1915, and will afford opportunity for use by the visitors to the Panama-Pacific Exposition.

SACRAMENTO, CAL.—A traffic agreement has been entered into between the Santa Fe Railroad and the electric roads communicating with the Sacramento Valley towns, giving all points on the Central California Traction, the Northern Electric and the Vallejo and Northern roads direct connection with the Santa Fe. The principal points benefited are Lodi, Sacramento, Marysville, Yuba City, Gridley, Oroville, and Chico. Woodland will shortly be benefited by it through the building of the Sacramento-Woodland line,now under construction.

FRESNO, CAL.—The group of Fresno and Coalinga capitalists which is engaged in financing a railroad from this city to Monterey, by way of Coalinga, has outlined plans for three branch lines, according to President A. Albrecht of the company. One branch is to run from Hollister to San Jose, another from Hollister to Santa Cruz, by way of Watsonville, and another from Coalinga to Maricopa and Bakersfield. Efforts are now being concentrated on the plans for the main line, which is to be built by subscription of residents of Central California.

LOS ANGELES, CAL.—Two new cross-town electric roads are to be built in this city. The routes to be followed are: North and south line—From Bimini Baths south on Vermont avenue to Vernon avenue. East on Vernon avenue to the city limits. East and west line—From the city limits west on Jefferson street to Main. East from Main on Jefferson to Central avenue. South on Central avenue to 38th street East on 38th street to Hooper avenue. Possibly from Hooper avenue east to 38th to city limits. This will mean about eight and one-half miles of new trackage.

MARYSVILLE, CAL.—The Pacific Gas & Electric Co., promoters of the proposed California Midland Railroad, connecting Marysville and Grass Valley, have taken over the stock of the Nevada County Traction Co., operating between Grass Valley and Nevada City and have an option for purchase of stock of the Nevada County narrow-gauge connecting Nevada City and Grass Valley with the Southern Pacific at Colfax. The acquisition of this stock is believed to mean a merger that will result in the building of the California Midland. Work is to begin within 60 days, according to announcement made here by George A. Aldrich. The road will be a broad-gauge, probably operated by electricity. It will connect Marysville, Hammonton, Spenceville and Grass Valley and Nevada City. The Nevada County narrow-gauge will give the line direct connection with the main line of the Southern Pacific. Eight miles of road have been graded between Marysville and Hammonton.

TELEPHONE AND TELEGRAPH.

REARDAN, WASH.—The Washington Consolidated Telephone and Telegraph Co. has been granted permission to build a line on Maple street.

LAKEVIEW, ORE. C. H. Lee has taken the contract for the extension of the Nevada, California and Oregon Telegraph and Telephone lines to Lakeview.

PRINEVILLE, ORE.—The Oregon Central Telephone Co. has incorporated with capital stock of $50,000. Louis Doonar, O. R. Cook and N. W. Sanborn are the incorporators.

SPOKANE, WASH.—S. T. Spence of San Francisco has been awarded the contract for the completion of the Pacific States Telephone and Telegraph Company's building at Second Avenue and Stevens Street, at $129,760.

Pasco, Wash.—Estimates have been completed and plans are being made for installing a new system by the Twin City Telephone Co. According to Manager R. A. Klinge, about $30,000 will be spent. It is planned to place all wires under ground ultimately.

KELSO, WASH.—The Coweeman Telephone company will extend its lines on the Coweeman into Shanghai valley. The Company has bought the poles from Beck Bros., and as soon as the ground softens up, workmen will commence digging and setting poles.

ALPHABETICAL INDEX TO ADVERTISERS

JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXVII SAN FRANCISCO, SEPTEMBER 9, 1911 NUMBER 11

ELECTRICALLY DRIVEN DONKEY ENGINES

BY AUGUST WOLF.

Donkey engines driven by electricity are the latest features of modern logging operations in the Spokane district and it is planned to extend their use to forests in other parts of the Pacific Slope and intermountain country. It is predicted by engineers that the electrification of logging roads naturally will follow the adoption of electric logging on a large scale. The advantages claimed are the elimination of fire risk, the ease of power transmission and the use for large quantities of wood, now destroyed as refuse by many lumber mills in the Northwest.

Potlatch Lumber Company's Plant, Where First Electrically Driven Donkey Engines Were Installed.

The first electric donkey engines to be used in the Northwestern forests are at Potlatch, Idaho. They are built on lines originating by E. J. Barry, electrical engineer of the Potlatch Lumber Company, who, for experimental purposes, converted a steam donkey machine by gearing the motor to the position formerly occupied by the boiler. A motor-driven compressor supplies air for the signal whistle. The apparatus, specially built for severe service, is a 150-h.p., 3-phase, 550-volt, 60-cycle, 435-r.p.m. motor, equipped with a current limiting device. The engine handles an average of 35,000 feet of logs a day. Ten engines to handle from 300,000 to 500,000 feet a day will be installed to replace steam engines.

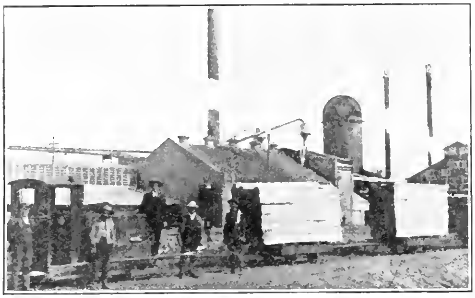
Should the tests of the Potlatch Lumber Company prove successful it will be necessary to step up the present voltage of 550 to a pressure which will allow of transmission over a large area. Transformers for this purpose, giving two voltages of 11,000 and 22,000 volts respectively, according to connection, will be used; 11,000 volts will be used till the requirements exceed economical transmission at this pressure, when a change will be made by reconnecting the transformers for 22,000 volts. This will allow a 20-mile radius for power transmission.

In operating motors it will be necessary to have the supply wires taken over ground from which the standing timber has been cleared, owing to the danger of interrupted service through trees falling on the

line. This will be arranged by having the transmission lines always in the rear of the logger and consequently built over logged-off land. A portable sub-station consisting of one 3-phase transformer of 150 kilowatt capacity will be placed at a convenient point for stepping down the voltage from 11,000 to 550.

From the sub-station a 3-core steel armored cable will run to the motor on the logger, this cable being supplied in sections to allow the logger being warped out up to a distance of 1800 feet from the sub-station. Mr. Barry is confident that within its capacity a motor will do all expected of it and still have a good reserve fund of energy for overloads.

Regarding the electrification of logging roads, it is found that the first cost of an electric road is high in



Transportation of Lumber From Mill to Yard by Electric Storage Battery Locomotive.

comparison with steam, varying from two and a half to three times in initial outlay, owing to the expense of poles, insulators, trolley lines, transformers, rail bonding and the labor involved in installing the apparatus. Maintenance costs are less, varying from 8 to 10 per cent. Delays through breakdowns have decreased one-third since adopting electric drive on a road previously operated by steam. The average cost of electric locomotives is from $11,000 to $16,000, dependent on size and capacity, about the same as for steam locomatives.

Probably the greatest advantage of electric drive is the fact that a use may be found for the large quantities of fuel now burned uselessly as refuse by every lumber mill. Many thousands of horsepower are thus wasted every year, and it is surely time, in this era of conservation, to try to reduce this loss to a minimum, and much credit is due to the Potlatch Lumber Company's officials for their pioneer service in this line of power use.

FAR EASTERN NEWS.

The waterworks and electric-light company at Newchwang has been taken over by the South Manchuria Railway Co.

The projectors of the Inawashiro Hydroelectric Power Co. have at length received a charter from the Government. The projectors are among the leading business men of Japan, namely, Baron Shibusawa, Mr. R. Kondo, and Mr. R. Toyokawa. Their idea is to obtain water from Inawashiro Lake, 50 miles from Tokyo, and they put their capital at $10,500,000.

PACIFIC COAST GAS ASSOCIATION.

The nineteenth annual convention of the Pacific Coast Gas Association will be held in Oakland, California, September 19, 20 and 21. Through the energy and enterprise of F. A. Leach, Jr., president of the association, and John A. Britton, secretary, not only the high standard of former conventions will be maintained but every indication points to a meeting even more entertaining and profitable than in the past. The following papers will be read at the convention:

President's Address.........Frank A. Leach, Jr.
1. Unstable Hydrocarbons in Illuminating Gas,. ....E. C. Jones
2. Suburban Gas Distribution....C. S. S. Forney
3. Rate Fixing....................Prof. C. L. Cory
4. The Napthalene Problem in Oil Gas, Manufacture and distribution...........F. S. Wade
5. Early Gas Lighting ....W. R. Morgan
6. Mechanical Handling of Carbon By-Product of the Oil Gas Process...........D. J. Young
7. The Gas Meter ....W. M. DuVal
8. (Title to be announced)...........H. H. Jones
9. Wrinkles ....F. C. Millard
10. Experiences ....John D. Kuster
11. Novelties....................... John Clement

The meeting will be held in Forester's Hall, S. E. Corner of 13th and Clay Streets, opposite the office of the Oakland Gas, Light & Heat Co., and will be called to order promptly at 10:00 o'clock A. M., September 19th.

Arrangements have been made with the Southern Pacific Company, whereby the members attending the Convention will be given a rate of one and one-third fare for the round trip (Receipt certificate plan), and which plan will be in force for the period from September 9 to 21.

The Banquet will be held in the Key Route Inn, on Wednesday evening, September 20th, at 7:00 o'clock and the outing, to be given by the Pacific Gas and Electric Company, will consist of a trolley trip in special cars, starting from the 22nd Street Terminus of the Key Route, at the Key Route Inn, at 9:30 o'clock Thursday morning, September 21st.

The cars will pass through Berkeley, Emeryville, Albany and Pullman, to Richmond, and, through the courtesy of the Standard Oil Company, a visit will be made to its great oil refineries at that point. The return trip will be made to Piedmont Park, via Oakland, where luncheon will be served at 1:00 o'clock P.M., after which the members will be given ample opportunity to visit the beautiful gardens and the extensive Art Gallery of Mr. F. C. Havens, which is located in the Park. On leaving the Park the route of the cars will be to San Leandro and Hayward, returning to Oakland via Alameda. The trip in all will afford the members a delightful outing, and also give them a conception of the scenic beauties of Alameda County. Headquarters for ladies during the Convention will be maintained at the Key Route Inn, where a Committee of Oakland ladies will be in attendance.

THE USE OF THE TRIPLE RATING OF INCANDESCENT LAMPS.

BY L. S. TWOMEY.

The function of any incandescent lamp is the production of light. The man purchasing a lamp is paying for an instrument for the production of light and not for a power consuming device. He is interested in the cost of the lamp only insofar as it effects the ultimate cost of producing light.

The cost of producing light is influenced by the cost of lamp renewals and the cost of energy. These factors in turn depend on the price of the lamp, the life of the lamp, the cost of energy per kilowatt-hour the power consumption of the lamp and its total luminous output. There is a relation between these items which determines the most economical operating conditions for a lamp for various costs of energy. The cost of the lamp divided by the hours life, divided by the luminous output of the lamp, gives the cost of lamp renewals per unit of light flux. The energy consumption per hour multiplied by the energy cost rate, divided by the luminous output, gives the energy cost per unit of light flux. The sum of these two costs is the true cost of light. The curves in Fig. 1, represent these costs graphically for any single cost of energy under varying operating conditions. The minimum point of the total cost curve represents the point of most economical operating conditions for that cost of power and for that particular lamp.

By burning the lamp at high efficiency, the power cost for a given amount of light may be decreased, but the renewal cost is increased. Computing the minimum cost of light for different energy rates it has been found that for low energy rates the lamp should be burned at low efficiency on high watts-per-candle, and that for high energy rates it should be burned at high efficiency with a corresponding sacrifice in life. In recognition of this fact the triple rating of incandescent lamps has been introduced.

By this method of rating three voltages are given on the label, the top voltage of which corresponds to the highest efficiency or lowest energy consumption per unit of light flux, and the bottom voltage corresponds to the lowest efficiency and longest life. In this way the customer with a high energy rate can order high efficiency lamps for his circuit and the customer with the low energy rate can order low efficiency lamps and thus approximate the most economical condition.

The accompanying tables have been computed to show the amount of light obtained per dollar expended for energy and lamp renewals. The darkened figures represent the most economical operation and show how this shifts from low to high efficiency as the energy rate increases. The unit of light flux which has been used is the lumen hour, which is that quantity of light

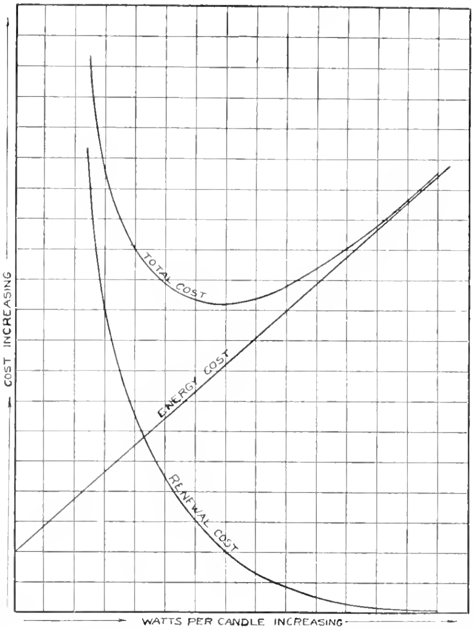


Fig. 1. Graphical Illustration of Lamp Costs for Varying Energy Costs and Operating Conditions.

which will illuminate an area of one square foot to the intensity of one foot candle for a period of one hour. The tables are given to show how the minimum cost of light shifts from low efficiency to high efficiency with increasing cost of energy and incidentally it

TABLE NO. 1

Showing Cost of Producing Light with "Mazda" Lamps at "High," "Medium" and "Low" Efficiency.

Nominal Watts.	25			40			60			100		
Efficiency Step.	High.	Med.	Low.	High.	Med.	Low.	High.	Med.	Low.	High.	Med.	Low.
Variable Cost of Energy.	Thousands of Lumen-Hours obtained per dollar expended for Power and Lamp Renewals.											
1 cent per kw. hour	208.	232.	**263.**	294.	322	**357.**	303.	315.	**370.**	357.	385.	**417.**
2 " " " "	161.	175.	**189.**	213.	227.	**238.**	222.	238	**250.**	250.	256.	**270.**
3 " " " "	133.	141.	**147.**	170.	175	**179.**	175.	185	**189.**	192.	196.	**200.**
4 " " " "	114.	118.	**122.**	139.	141	**145.**	145.	149	**152.**	156.	156.	**159.**
5 " " " "	98.	101.	**103.**	119.	119	**120.**	123	**127.**	**127.**	**131.**	**131.**	**131.**
6 " " " "	87.	89	**90.**	103.	103.	**104.**	108.	**109.**	**109.**	**114.**	113.	111.
8 " " " "	70.	71.	**71.**	**82.**	81	81.	**86.**	**86.**	85	**89.**	88.	86.
10 " " " "	**59.**	**59.**	59.	**68.**	67.	66.	**71.**	70.	69.	**74.**	71.	70.
12 " " " "	**51.**	**51.**	50.	**58.**	57.	56	**61.**	60.	59	**63.**	61.	59.

TABLE NO. 2.

Showing Cost of Producing Light with Carbon Lamps at "High," "Medium" and "Low" Efficiency.

Nominal Watts.	50			60			100			120		
Efficiency Step.	High.	Med.	Low.	High.	Med.	Low.	High.	Med.	Low	High.	Med.	Low.
Variable Cost of Energy.	Thousands of Lumen-Hours obtained per dollar expended for Power and Lamp Renewals.											
1 cent per kw. hour	222.	232.	**238.**	232.	**244.**	**241.**	232	238	**241.**	244.	250.	**256.**
2 " " " "	**135.**	**135.**	133.	**141.**	**141.**	137.	**139.**	**139.**	137	**145.**	143.	139.
3 " " " "	**97.**	96.	94.	100.	98.	94.	**100.**	97.	94	**102.**	99.	95.
4 " " " "	**76.**	74.	71.	**77.**	76.	72.	**77.**	75.	72	**79.**	76.	72.
5 " " " "	**63.**	61.	58.	**63.**	61.	58.	**63.**	61.	58.	**65.**	62.	59.
6 " " " "	**53.**	51.	49.	**54.**	52.	49.	**54.**	52.	49.	**54.**	52.	49.
8 " " " "	**41.**	39.	37.	**41.**	39	37.	**41.**	39.	37.	**42.**	39.	37.
10 " " " "	**33.**	31.	30.	**33.**	32.	30.	**33.**	32.	30.	**34.**	32.	30.
12 " " " "	**28.**	26.	25.	**28.**	26.	25.	**28.**	26.	25.	**28.**	27.	**25.**

shows the economy of the "Mazda" lamp over the carbon filament lamp as a producer of light.

These tables are based on the list price of the lamps. Where lamps are purchased in quantities large enough to secure quantity discounts the number of lumen-hours per dollar will be increased. The increase would be greater for low energy rate so that the effect of the lower cost of the lamp is to lower the energy cost at which the most economical conditions of operation (indicated by the figures in black-faced type) changes from low to medium or medium to high efficiency. In table No. 1 it will be noticed that the critical cost of power at which the point of maximum light output per dollar shifts from low to high efficiency, is lower the higher the wattage consumption of the lamp.

In cases where the percentage saving in the use of low efficiency is small the better color value of the light from the lamp operated at high efficiency together with the greater amount of light obtained from a single unit, are of much greater importance than the saving. For this reason it may be said that for the larger sizes of "Mazda" lamps high efficiency should be used for all costs of energy, exceeding 3 or 4 cents per kilowatt-hour. Similarly, carbon filament lamps should be burned at high efficiency for all costs of energy exceeding 2 cents per kilowatt-hour.

Comparing the table for "Mazda" lamps with that for carbon filament lamps it will be seen that the percentage saving of "Mazda" over carbon filament lamps is greater the higher the energy rate.

The effect of the introduction of the triple rating of incandescent lamps has been a greater flexibility to meet the large variety of conditions under which incandescent lamps are bought and used.

INTERNATIONAL ELECTRICAL CONGRESS AT PANAMA-PACIFIC EXPOSITION 1915.

One of the most fruitful results of a great international exposition is that brought about by the gathering together of the peoples of the world for discussion. At such times ideas are brought forth and comparisons of methods made which could never be accomplished in any other way.

That the great western metropolis of San Francisco is to be honored by the most distinguished electrical congress ever convened was assured by a recent action of the Board of Directors of the American Institute of Electrical Engineers. It will not be surprising if this congress assembled under the clear blue skies of California should awaken new scientific truths and instill new impetus for invention in the electrical industry.

Briefly the beginning of this great movement has had its inception in the following lines. We are indebted to the Electrical Review for the first inkling of the good news. At the meeting of the Board of Directors of the American Institute of Electrical Engineers, held on August 22, the following resolutions were adopted:

Resolved: That it is the sense of the Board of Directors that it would be desirable to hold an International Electrical Congress during the Panama Exposition in San Francisco in 1915, and that such a Congress be initiated and conducted by the American Institute of Electrical Engineers under the authority of the International Electrotechnical Commission.

Resolved: That in furtherance of the project to hold an International Electrical Congress during the Panama Exposition at San Francisco in 1915, a committee on Congress organization be authorized, the members of same to be appointed by the President after receipt of such information from the International Electrotechnical Commission as would indicate a disposition on their part to authorize the American Institute of Electrical Engineers in the holding of such a Congress.

FRAUDULENT OIL ENTRIES.

Three ways to get oil lands by false pretenses now used in California, so State Mineralogist Aubury says, are homestead entries, desert land entries and scrip filings. All of these methods have been tried in the San Joaquin Valley, so Aubury asserts, and the attempts to get valuable oil lands without any due observance of the law have been so successful that he has found it to be his duty to call the attention of the Federal officials to the matter.

MINE SAFETY DEMONSTRATION.

Thirty thousand miners are expected to attend the great national Mine Safety Demonstration to be held in Pittsburg, Pa., October 26 and 27 under the auspices of the Federal Bureau of Mines, the American Red Cross, the Pittsburg Coal Operators' Association and the United Mine Workers of America.

The demonstration, the purpose of which is to teach greater safety in mining, will begin the morning of October 26, at the experiment station of the Bureau of Mines, Fortieth and Butler streets. The first day will be devoted to the interests of the mine operators, mine owners, mining engineers and superintendents of mines. There will be an explosion of coal dust in the experiment gallery and tests of mine safety lamps in gas. The dangers of electric sparks in gas and coal dust will also be shown in the galleries.

SHORT-CUT IN ESTIMATING EXCAVATION OF YARDAGE IN DITCH CONSTRUCTION.

In ditch or railway surveys the location is usually made in 50 ft. or 100 ft. stations. The yardage in each 50 or 100 ft. segment is then figured by adding together the end areas in square ft., dividing by two and again dividing by 27 in order to convert into cubic yards. In order to save these successive steps the following tables have been carefully computed and double-checked.

In order to apply the table let us take a specific example. Let us suppose the sum of the end areas is 28.4 sq. ft. Find 28 in the first column, then read toward the right and under column headed .4 read 52.6. This means that a prism 100 ft. long whose end areas sum 28.4 sq. ft. contains 52.6 cu. yd. Should 50 ft. stations be used in location work, divide by 2 the amount so found. Where many stations are to be figured, the table will be found quick, accurate and a great time saver.

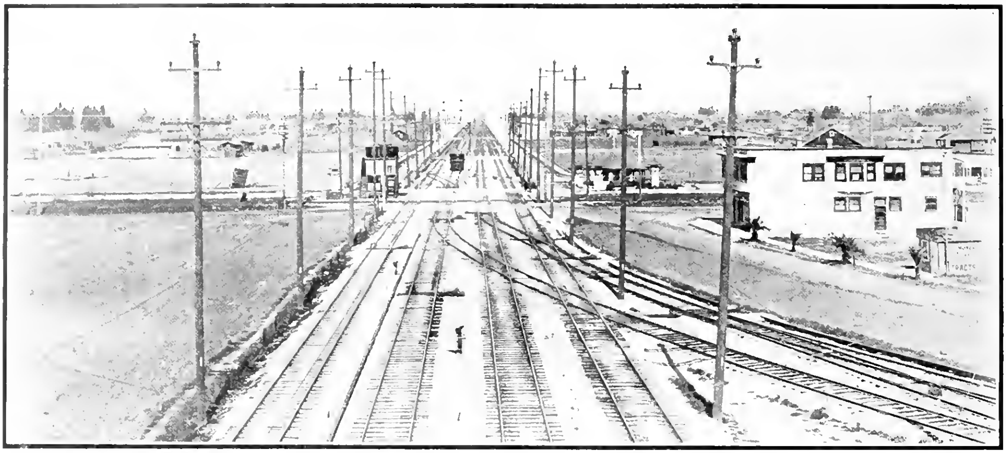
CUBIC YARDS IN PRISMS 100 FT. LONG BY SUM OF END AREAS.

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0	0	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	0
1	1.9	2.0	2.2	2.4	2.6	2.8	3.0	3.1	3.3	3.5	1
2	3.7	3.9	4.1	4.3	4.4	4.6	4.8	5.0	5.2	5.4	2
3	5.6	5.7	5.9	6.1	6.3	6.5	6.7	6.9	7.0	7.2	3
4	7.4	7.6	7.8	8.0	8.1	8.3	8.5	8.7	8.9	9.1	4
5	9.3	9.4	9.6	9.8	10.0	10.2	10.4	10.6	10.7	10.9	5
6	11.1	11.3	11.5	11.7	11.9	12.0	12.2	12.4	12.6	12.8	6
7	13.0	13.1	13.3	13.5	13.7	13.9	14.1	14.3	14.4	14.6	7
8	14.8	15.0	15.2	15.4	15.6	15.7	15.9	16.1	16.3	16.5	8
9	16.7	16.9	17.0	17.2	17.4	17.6	17.8	18.0	18.1	18.3	9
10	18.5	18.7	18.9	19.1	19.3	19.4	19.6	19.8	20.0	20.2	10
11	20.4	20.6	20.7	20.9	21.1	21.3	21.5	21.7	21.9	22.0	11
12	22.2	22.4	22.6	22.8	23.0	23.1	23.3	23.5	23.7	23.9	12
13	24.1	24.3	24.4	24.6	24.8	25.0	25.2	25.4	25.6	25.7	13
14	25.9	26.1	26.3	26.5	26.7	26.9	27.0	27.2	27.4	27.6	14
15	27.8	28.0	28.1	28.3	28.5	28.7	28.9	29.1	29.3	29.4	15
16	29.6	29.8	30.0	30.2	30.4	36.0	30.7	30.9	31.1	31.3	16
17	31.5	31.7	31.9	32.0	32.2	32.4	32.6	32.8	33.0	33.1	17
18	33.3	33.5	33.7	33.9	34.1	34.3	34.4	34.6	34.8	35.0	18
19	35.2	35.4	35.6	35.7	35.9	36.1	36.3	36.5	36.7	36.9	19
20	37.0	37.2	37.4	37.6	37.8	38.0	38.1	38.3	38.5	38.7	20
21	38.9	39.1	39.3	39.4	39.5	39.8	40.0	40.2	40.4	40.6	21
22	40.7	40.9	41.1	41.3	41.5	41.7	41.9	42.0	42.2	42.4	22
23	42.6	42.8	43.0	43.1	43.3	43.5	43.7	43.9	44.1	44.3	23
24	44.4	44.6	44.8	45.0	45.2	45.4	45.6	45.7	45.9	46.1	24
25	46.3	46.5	46.7	46.9	47.0	47.2	47.4	47.6	47.8	48.0	25
26	48.1	48.3	48.5	48.7	48.9	49.1	49.3	49.4	49.6	49.8	26
27	50.0	50.2	50.4	50.6	50.7	50.9	51.1	51.3	51.5	51.7	27
28	51.9	52.0	52.2	52.4	52.6	52.8	53.0	53.1	53.3	53.5	28
29	53.7	53.9	54.1	54.3	54.4	54.6	54.8	55.0	55.2	55.4	29
30	55.6	55.7	55.9	56.1	56.3	56.5	56.7	56.9	57.0	57.2	30
31	57.4	57.6	57.8	58.0	58.1	58.3	58.5	58.7	58.9	59.1	31
32	59.3	59.4	59.6	59.8	60.0	60.2	60.4	60.6	60.7	60.9	32
33	61.1	61.3	61.5	61.7	61.9	62.0	62.2	62.4	62.6	62.8	33
34	63.0	63.1	63.3	63.5	63.7	63.9	64.1	64.3	64.4	64.6	34
35	64.8	65.0	65.2	65.4	65.6	65.7	65.9	66.1	66.3	66.5	35
36	66.7	66.9	67.0	67.2	67.4	67.6	67.8	68.0	68.1	68.3	36
37	68.5	68.7	68.9	69.1	69.3	69.4	69.6	69.8	7.00	70.2	37
38	70.4	70.6	70.7	70.9	71.1	71.3	71.5	71.7	71.9	72.0	38
39	72.2	72.4	72.6	72.8	73.0	73.1	73.3	73.5	73.7	73.9	39
40	74.1	74.3	74.4	74.6	74.8	75.0	75.2	75.4	75.6	75.7	40
41	75.9	76.1	76.3	76.5	76.7	76.9	77.0	77.2	77.4	77.6	41
42	77.8	78.0	78.1	78.3	78.5	78.7	78.9	79.1	79.3	79.4	42
43	79.6	79.8	80.0	80.2	80.4	80.6	80.7	80.9	81.1	81.3	43
44	81.5	81.7	81.9	82.0	82.2	82.4	82.6	82.8	83.0	83.1	44
45	83.3	83.5	83.7	83.9	84.1	84.3	84.4	84.6	84.8	85.0	45
46	85.2	85.4	85.6	85.7	85.9	86.1	86.3	86.5	86.7	86.9	46
47	87.0	87.2	87.4	87.6	87.8	88.0	88.1	88.3	88.5	88.7	47
48	88.9	89.1	89.3	89.4	89.6	89.8	90.0	90.2	90.4	90.6	48
49	90.7	90.9	91.1	91.3	91.5	91.7	91.9	92.0	92.2	92.4	49
50	92.6	92.8	93.0	93.1	93.3	93.5	93.7	93.9	94.1	94.3	50

100	185.2	600	1,111.1	2,000	3,703.7
200	370.4	700	1,296.3	3,000	5,555.6
300	555.6	800	1,481.5	4,000	7,407.4
400	740.7	900	1,666.7	5,000	9,259.3
500	925.9	1,000	1,851.9	6,000	11,111.1

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
50	92.6	92.8	93.0	93.1	93.3	93.5	93.7	93.9	94.1	94.3	50
51	94.4	94.6	94.8	95.0	95.2	95.4	95.6	95.7	95.9	96.1	51
52	96.3	96.5	96.7	96.9	97.0	97.2	97.4	97.6	97.8	98.0	52
53	98.1	98.3	98.5	98.7	98.9	99.1	99.3	99.4	99.6	99.8	53
54	100.0	100.2	100.4	100.6	100.7	100.9	101.1	101.3	101.5	101.7	54
55	101.9	102.1	102.2	102.4	102.6	102.8	103.0	103.1	103.3	103.5	55
56	103.7	103.9	104.1	104.3	104.4	104.6	104.8	105.0	105.2	105.4	56
57	105.6	105.8	105.9	106.1	106.3	106.5	106.7	106.9	107.0	107.2	57
58	107.4	107.6	107.8	108.0	108.1	108.3	108.5	108.7	108.9	109.1	58
59	109.3	109.5	109.6	109.8	110.0	110.2	110.4	110.6	110.7	110.9	59
60	111.1	111.3	111.5	111.7	111.9	112.0	112.2	112.4	112.6	112.8	60
61	113.0	113.1	113.3	113.5	113.7	113.9	114.1	114.3	114.4	114.6	61
62	114.8	115.0	115.2	115.4	115.6	115.7	115.9	116.1	116.3	116.5	62
63	116.7	116.9	117.0	117.2	117.4	117.6	117.8	118.0	118.1	118.3	63
64	118.5	118.7	118.9	119.1	119.3	119.4	119.6	119.8	120.0	120.2	64
65	120.4	120.6	120.7	120.9	121.1	121.3	121.5	121.7	121.9	122.0	65
66	122.2	122.4	122.6	122.8	123.0	123.1	123.3	123.5	123.7	123.9	66
67	124.1	124.3	124.4	124.6	124.8	125.0	125.2	125.4	125.6	125.7	67
68	125.9	126.1	126.3	126.5	126.7	126.9	127.0	127.2	127.4	127.6	68
69	127.8	128.0	128.1	128.3	128.5	128.7	128.9	129.1	129.3	129.4	69
70	129.6	129.8	130.0	130.2	130.4	130.6	130.7	130.9	131.1	131.3	70
71	131.5	131.7	131.9	132.0	132.2	132.4	132.6	132.8	133.0	133.1	71
72	133.3	133.5	133.7	133.9	134.1	134.3	134.4	134.6	134.8	135.0	72
73	135.2	135.4	135.6	135.7	135.9	136.1	136.3	136.5	136.7	136.9	73
74	137.0	137.2	137.4	137.6	137.8	138.0	138.1	138.3	138.5	138.7	74
75	138.9	139.1	139.3	139.4	139.6	139.8	140.0	140.2	140.4	140.6	75
76	140.7	140.9	141.1	141.3	141.5	141.7	141.9	142.0	142.2	142.4	76
77	142.6	142.8	143.0	143.1	143.3	143.5	143.7	143.9	144.1	144.3	77
78	144.4	144.6	144.8	145.0	145.2	145.4	145.6	145.7	145.9	146.1	78
79	146.3	146.5	146.7	146.9	147.0	147.2	147.4	147.6	147.8	148.0	79
80	148.1	148.3	148.5	148.7	148.9	149.1	149.3	149.4	149.6	149.8	80
81	150.0	150.2	150.4	150.6	150.7	150.9	151.1	151.3	151.5	151.7	81
82	151.9	152.0	152.2	152.4	152.6	152.8	153.0	153.1	153.3	153.5	82
83	153.7	153.9	154.1	154.3	154.4	154.6	154.8	155.0	155.2	155.4	83
84	155.6	155.7	155.9	156.1	156.3	156.5	156.7	156.9	157.0	157.2	84
85	157.4	157.6	157.8	158.0	158.1	158.3	158.5	158.7	158.9	159.1	85
86	159.3	159.4	159.6	159.8	160.0	160.2	160.4	160.6	160.7	160.9	86
87	161.1	161.3	161.5	161.7	161.9	162.0	162.2	162.4	162.6	162.8	87
88	163.0	163.1	163.3	163.5	163.7	163.9	164.1	164.3	164.4	164.6	88
89	164.8	165.0	165.2	165.4	165.6	165.7	165.9	166.1	166.3	166.5	89
90	166.7	166.9	167.0	167.2	167.4	167.6	167.8	168.0	168.1	168.3	90
91	168.5	168.7	168.9	169.1	169.3	169.4	169.6	169.8	170.0	170.2	91
92	170.4	170.6	170.7	170.9	171.1	171.3	171.5	171.7	171.9	172.0	92
93	172.2	172.4	172.6	172.8	173.0	173.1	173.3	173.5	173.7	173.9	93
94	174.1	174.3	174.4	174.6	174.8	175.0	175.2	175.4	175.6	175.7	94
95	175.9	176.1	176.3	176.5	176.7	176.9	177.0	177.2	177.4	177.6	95
96	177.8	178.0	178.1	178.3	178.5	178.7	178.9	179.1	179.3	179.4	96
97	179.6	179.8	180.0	180.2	180.4	180.6	180.7	180.9	181.1	181.3	97
98	181.5	181.7	181.9	182.0	182.2	182.4	182.6	182.8	183.0	183.1	98
99	183.3	183.5	183.7	183.9	184.1	184.3	184.4	184.6	184.8	185.0	99
100	185.2	185.4	185.6	185.7	185.9	186.1	186.3	186.5	186.7	186.9	100

7,000	12,963.0	30,000	55,555.6	80,000	184,184.1
8,000	14,814.8	40,000	74,074.1	90,000	166,666.7
9,000	16,666.7	50,000	92,592.6	100,000	185,185.2
10,000	18,518.5	60,000	111,111.1	200,000	370,370.4
20,000	37,037.0	70,000	129,629.6	300,000	555,555.6



Electric Railway System Leading to Long Beach

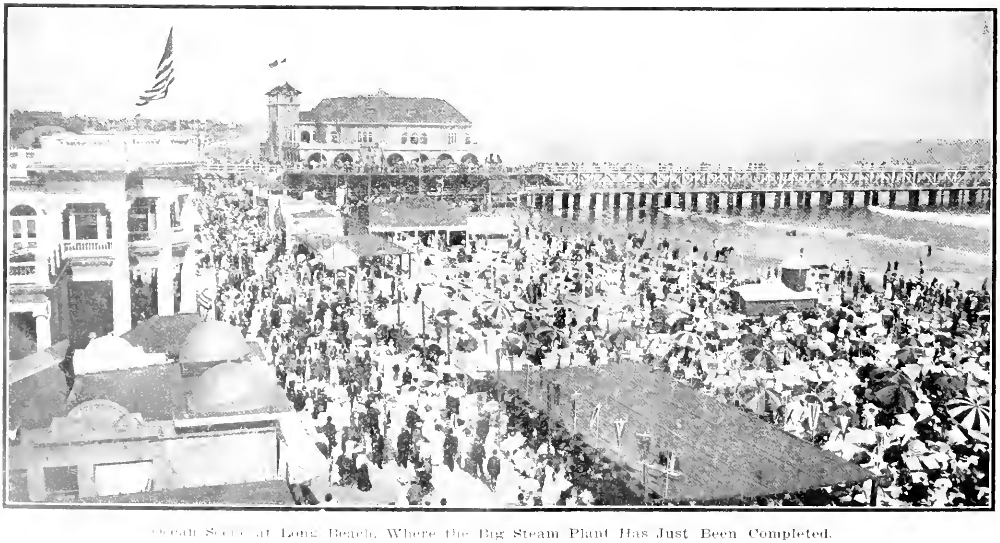
GREAT ELECTRICAL ACTIVITY IN SOUTHERN CALIFORNIA.

The steam plant of the Southern California Edison Company located at Long Beach, California, has recently been put into operation. The unit just completed has a capacity of 16,000 h.p. The generating unit is of the vertical steam turbine type and receives its steam from eight Sterling boilers. Crude oil is the fuel used.

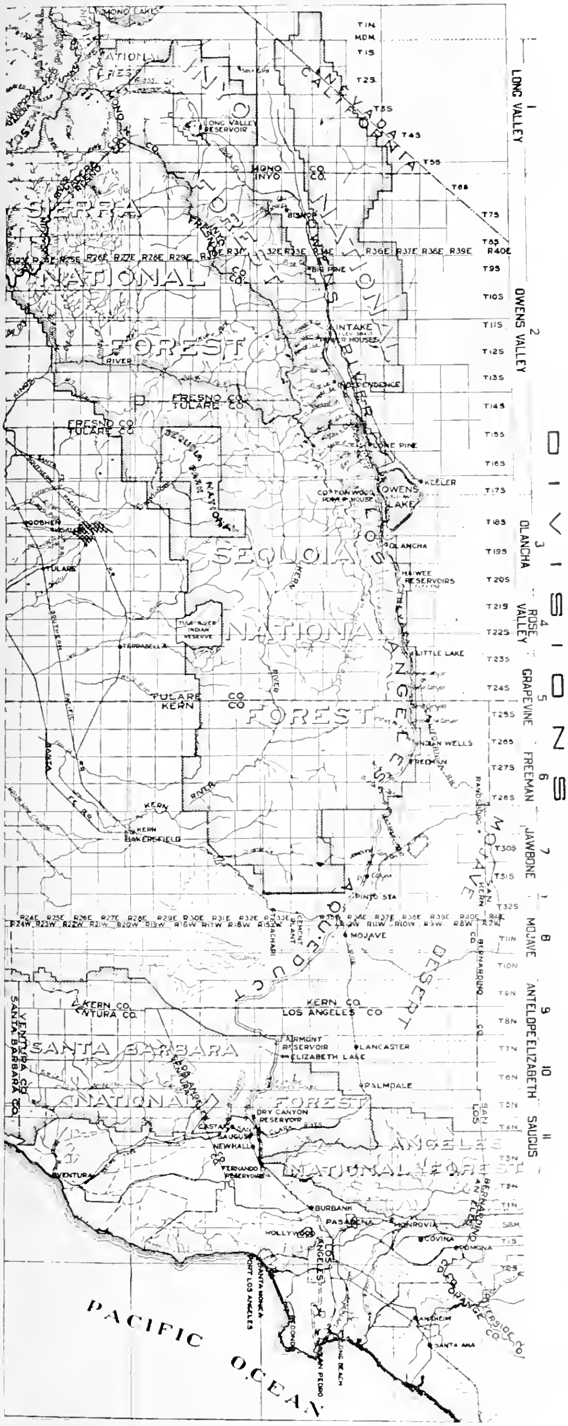
John D. Miller, president of the company, recently spoke of the enormous demands for power in Southern California. Portions of his remarks have previously been printed in the Journal, but in view of the agitation in Los Angeles looking toward an early development of thousands of h.p. from the Owens River project by the city of Los Angeles, it is interesting to see how private corporations view this activity in the way of additional power output. Mr. Miller's remarks are as follows:

"During May of this year, the consumption of electricity for power purposes far exceeded the demand for light. Since 1904 our power business has been gradually gaining upon the light business, notwithstanding the enormous increase of the latter which grew 128 per cent during the period of 1904 to 1910. Power won out in the long run during the month of May showing an earning of $4,771.95 in excess of lighting.

Throughout the months of this year, 1911, the same condition has held—power showing an excess of $28,148.53. During the corresponding months of 1910 the condition was reversed, light exceeding power in May by $2,492.40 and in June by $16,837.55. In 1904 our power earnings were over 22% of our gross electric earnings; in 1905 they increased to 24%; in 1906 to 29%; in 1907 to 32%; in 1908 to 35%; n 1909 to 41% and in 1910 to 47% passing the 50% mark in May of this year as I have stated."



Ocean Scene at Long Beach, Where the Big Steam Plant Has Just Been Completed.



Owens River Project, Which Will Develop Thousands of Horsepower for Los Angeles.

PRIMER OF APPLIED THERMODYNAMICS.[1]

Second Lecture.

Thermometers and Calorimetry.

Having now acquired a clear conception of the difference between "quantity of heat" and "temperature," we shall next proceed to consider the various methods in use in determining the numerical values of these physical conceptions.

We have seen how the selection or construction of the scale to be employed in measurement of temperatures is arbitrary, but having decided upon our definite fixed physical temperature points, such as the freezing of water and its boiling under standard conditions we now proceed with methods and devices employed in construction of thermometers. In 1836, Pouillet, after a series of investigations, found that the temperature of furnaces can be estimated with considerable accuracy by the color of the fire, and that with a little practice the error at any high temperatures will not exceed 90 deg. or 100 deg. F. In 1899, Howe, Maunsel & Taylor revised the results of Pouillet's observations. These are shown in Fig. 5, where may be found the color of the fire opposite the particular temperature.

In a bulletin published by the Bureau of Standards in 1905, it is stated that skilled observers may vary 100 deg. F. or more in their estimation by color of relatively low temperature and beyond 2200 deg. F. it is practically impossible to make estimations with any degree of certainty.

The air thermometer is one of the most delicate means of measuring temperatures, but due to its necessary accurate adjustments and auxiliary scientific data to be taken simultaneously, its use is largely restricted to the physical and chemical laboratories. There are six principal methods or devices employed in engineering practice in determining temperatures and they are as follows:

1. Alcoholic thermometer.
2. Mercurial thermometer or pyrometer.
3. Expansion pyrometer.
4. Melting points of metals.
5. Le Chatelier's thermo-electric pyrometer.
6. Calorimetry.

1. As alcohol has a very low freezing point, in fact so low that it cannot be reached by any natural temperature, its use is especially recommended in measurements, where low temperatures are to be taken. Since its boiling point is comparatively low, it is not at all useful, however, for high temperatures.

2. Mercury is an excellent substance to use in thermometers, as the variation in its expansion coefficient with rise of temperature is such that the deleterious effect of the expansion coefficient in the glass tube is very nearly offset by the compensating error introduced by assuming a constant expansion coefficient for the Mercury. Mercury boils at 676 deg. F. and for many degrees below this point gives off considerable vapor. As a consequence the ordinary mercurial thermometer can not be depended upon for a higher tem-

[1]A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

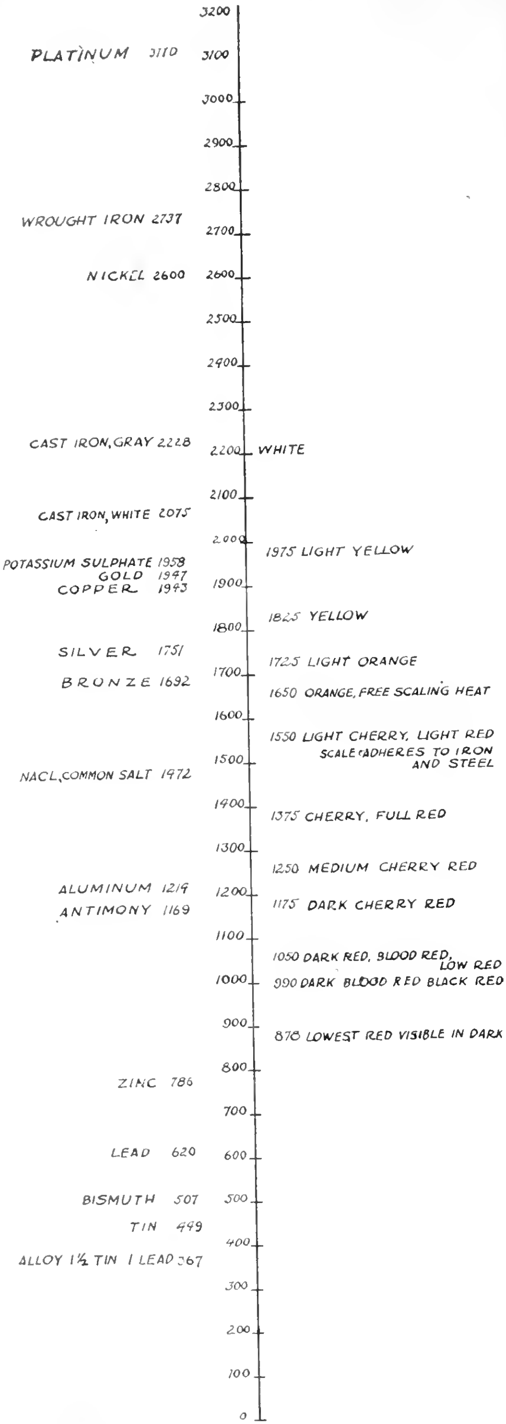


Fig. 5. A Fahrenheit scale from 0° to 3200°. On the left is a list of melting points of metals and on the right the colors of a furnace fire at particular temperatures.

perature than 500 deg. F. A very ingenious device, nevertheless, enables us to make use of the mercurial thermometer up to 800 deg. F. A small amount of nitrogen gas is put in the upper column of the tube and as the mercury column expands it consequently compresses the nitrogen gas. The reactive pressure of the gas upon the mercury raises its boiling point sufficiently to allow us to read up to 800 deg. F., as mentioned above. Since chimney gases are below this temperature, the mercurial pyrometer is very appropriate for determination of their temperatures. The bulb of the instument should project into the path of maximum velocity of the escaping gases in order that average temperature may be obtained, and before a reading is taken, it is necessary to keep the thermometer inserted in the flue socket from seven to fifteen minutes, depending on conditions.

Expansion pyrometers are useful for temperatures up to 1500 deg. F. It is a matter of common knowledge that when heat is applied to a substance it changes its volume, usually by increasing the volume, although there are notable exceptions. Different bodies expand by different amounts for the same increase in temperature. If now we take an iron pipe and within it insert a brass rod which expands about 50 per cent more than iron for a given rise in temperature, we can by rigidly attaching one end of the brass rod to a cap on one end of the iron pipe, construct a device that will indicate the temperatures. All that is necessary to do is to attach a multiplying device to the free ends and calibrate the readings of a pointer actuated by the multiplying device. When the instrument is first placed in a fire, it is found to read backwards, and when taken out it runs higher up the scale before dropping to the lower temperature. This is caused by the fact that the new change of temperature is first felt in the iron since time is necessary to conduct heat into the brass, consequently in the use of an instrument of this sort great care must be exerted to see that temperatures are even throughout the entire lengths of iron and brass.

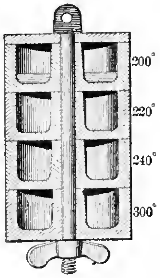


Fig. 6.

The melting points of metals give a very convenient method for determining ranges of temperature up to the melting point of platinum, 3110 deg. F. Upon the diagrammatic representation, Fig. 5, are platted various melting points, and it will be seen that by proper choice of metals. Temperature differences of every 200 deg. change can be noted. A device similar to Fig. 6 is convenient in the arrange-

ment of the metals for this test. As will be noted the method lacks accuracy, but it suffices very well for the approximate determination of the temperatures of the furnace, and in different parts of the tubes of a boiler.

Of the many useful and practical engineering methods at our disposal for the measurement of high temperatures, the most accurate, and at the same time the most interesting, is that known as the thermo-electric pyrometer. It is a peculiar phenomenon, yet none the less true that if we join together two different metals and heat this junction, an electromotive force is set up between the outer ends of the wires. This electromotive force depends upon two things, first the composition of the wires and second the temperature. Hence if we choose any two wires, the electromotive force depends directly upon the temperature. In the thermo-electric pyrometer of Le Chatelier, the wires are platinum and a 10 per cent alloy of platinum and rhodium, inclosed in porcelain tubes to protect them from the oxidizing influence of the furnace gases. Since, as noted above, the electromotive force, depends on the temperature of the junction alone it is not necessary to expose the entire element to the fire, bue solely the junction, nor is it necessary that the galvanometer or instrument used to measure the electro-motive force be near the element—as a considerable addition of lead wires has no practical effect on its readings. The continuity of the readings by means of a thermo-electric device is perfect, and, as it is extremely accurate, the ease with which the readings are made commends its use. The high first cost of the instrument is its material drawback for universal adoption.

Of all the methods of temperature measurement, that known as the calorimetry process is the most readily accessible, and where extreme accuracy is not desired, it is found to be most useful. The savage long since discovered that water in a scooped out log could be made to boil, not by putting the inflammable log over his fire but by dropping into the water-filled hollow log heated rocks picked from the hot coals. So it is, if we take from a boiler furnace a piece of iron heated to the same furnace temperature and drop it into water, the temperature of the water is raised a definite amount, and if we know the weight of the hot substance, its specific heat together with the weight of the water and its rise in temperature, we can compute the temperature of the furnace whence came the hot body. Since we have found that heat is a form of energy, and since energy is indestructible, if there is no radiation, the amount of heat energy given up by the hot substance must be exactly equal to the amount gained by the water.

Hence if—

X = unknown temperature of the hot substance.
w = weight of hot substance in lb.
W = weight of water in lb.
T = final temperature of water.
t = temperature rise, or difference between initial and final temperatures of water.
s = specific heat of hot substance, then, since heat lost by hot substance = heat gained by water

$$w\ (X-T)\ s = Wt$$
$$wsX - wsT = Wt$$
$$\text{or } X = T + \frac{Wt}{ws}$$

As an example, let us suppose that 4 lb. of cast iron, which has been heated to an unknown temperature be plunged into 20 lb. of water at 64 deg. F. heating it thereby to 124 deg. F. Then substituting we have

$$X = 64 + \frac{20 \times 60}{4 \times .180}$$
$$= 64 + 1667 = 1731° \text{ F.}$$

In order to get refined results many sources of error must be properly taken care of in this method, but for convenience and application to usual approximate temperature tests, it excels all others.

Some convenient substances and their specific heats are as follows:

TABLE II.
Mean Specific Heats.

Substance	Ordinary Temperature.	Mean for High Temperature.
Platinum	.032	.038
Iron (cast)	.130	.180
Nickel	.109	.136
Fire	.200	.260

CALORIMETRY

In engineering practice, the question of quantity of heat usually arises in the study of fuels. Thus, in order to obtain the efficiency of a boiler, it is necessary to know the amount of heat given off by the fuels employed in combustion. The fuels may be solids such as coal, wood, bagasse, or liquids such as petroleum, or gases such as natural or producer gas. The different methods in practice employed in the measurement of quantities of heat are classified under the heading of calorimetry.

The heating value of fuels may be determined with more or less approximation to accuracy by three different methods: namely, by chemical analysis, by combustion in one of the so called calorimeters and by actual trial in a steam boiler. The accuracy of the first two methods depends on the precision of the method of analysis or calorimetry adopted, and upon the care and skill of the operator. The results of the third method are subject to numerous sources of variation and error, and may be taken as approximately true only for the particular conditions under which the test is made. Analysis and calorimetry give with considerable accuracy the heating value which may be obtained under the conditions of perfect combustion and complete absorption of the heat produced. A boiler test gives the actual result under conditions of more or less imperfect combustion, and of numerous and variable wastes.

There are many forms of calorimeters on the market but two seem to possess such exceptional merits that we shall consider these alone.

The Parr Calorimeter is the invention of S. W. Parr, Professor of Applied Chemistry at the University of Illinois. A large number of the descriptive words of the inventor are used in the following brief description of the process. It has the advantage of operating without an oxygen gas supply; its manipulation is simple and the extraction of the heat rapid, owing to the compact mass in which the heat is

generated. It is designed for technical purposes and its factor of error is well within 0.5 per cent. The Parr Calorimeter depends for its action upon the liberation of oxygen from a compound which shall in turn absorb the products of combustion, conditions admirably met in sodium peroxide; this obviates the necessity of providing for an outlet for those gases and also any loss arising from the heat they might carry off.

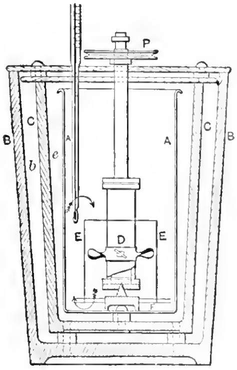


Fig. 7.

A, Fig. 7, is the calorimeter of about two liters capacity, insulated by two outer vessels of indurated fibre, B and C, so placed as to provide further insulation by the air-spaces b and c. The cover is double, to correspond with the air-space between, the two parts being connected for convenience in handling. The cartridge D has a capacity of about 25 cubic centimeters; it rests on a pivot below, extends through the covers, and has a small removable pulley at the end. Turbine wings fastened to spring clips placed on the cartridge, and a short cylinder E, open at both ends, is provided for directing the current set up by rotation of the vanes attached to the cartridge. The stem of the cartridge is so arranged as to permit the passage of a short piece of No. 12 copper wire to ignite the charge; it is provided with a valve D at the lower end to prevent the escape of the enclosed air.

A test is made in the following manner. One gram of coal ground to pass a 100-mesh sieve, dried at 105 deg. C., is put into the cartridge, 16-18 grams of sodium peroxide added, the top screwed on, and the whole shaken to thoroughly mix the contents. The peroxide should be fine enough to pass a 25-mesh sieve. The cartridge is tapped to settle the charge to the bottom, then placed in the calorimeter which contains two liters of water. It is then rotated 50 to 100 revolutions per minute. The water should be 3 to 4 degrees lower than the room temperature. When the temperature has become constant the thermometer is read, a hot wire dropped down, ignites the charge, which burns completely. The extraction of the heat is effected in about five minutes; the reading of the maximum temperature is taken and the calculations made as follows: the rise of temperature is corrected, first, for that produced by the hot wire; this amounts to 0.006 deg. C. per ¼ inch of No. 12 copper wire; second, for the heat produced by the combination of the sodium peroxide with the carbon dioxide and water formed by the combustion; this amounts to 27 per cent of the total indicated heat. If C equals the heat of combustion of the coal, C^1 the calories indicated, t the rise of temperature, and w the water employed, then

$$C^1 = (t - 0.006^\circ) \times W, \quad C = C^1 - \frac{C^1 \times 27}{100}$$

$$\text{or} \quad C = (t - 0.006^\circ) \times W \times 0.73.$$

The residue from the combination contains the carbon of the coal in the form of sodium carbonate. The volume of carbon dioxide may readily be measured, and from this the total carbon of the coal can be calculated. This is a result not heretofore available except by ultimate analysis, and enhances the value of the instrument.

The Sargent automatic gas calorimeter is used to determine the calorific value as well as the foreign matter in gases. The method is quick, simple and accurate. Fig. 8 shows a section of the Sargent calorimeter. It is seen that the inlet water having a constant head at the cistern E, the temperature of which is taken at C, envelopes the whole instrument and passes through in the direction of the arrows. The rise in the temperature is taken by the thermometer at D before any heat is lost by radiation to the air. The combustion of gas takes place in the central flue, and the products of combustion pass to the top and down the annular chambers in the direction of the arrows, reaching the temperature of the water before

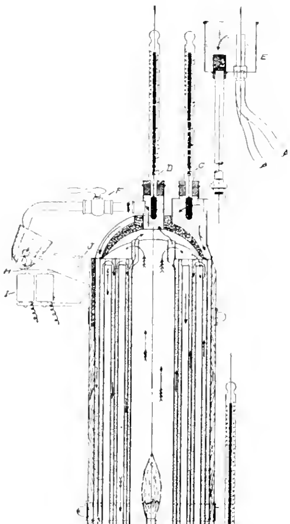


Fig. 8.

passing out at B, where a damper regulates the velocity, and the thermometeer gives the temperature of the exhaust products. A device is attached so that

the amount of water is very accurately weighed every time 1-10 of a cubic foot of gas is consumed. By means of the thermometers, the rise in temperature is ascertained, consequently we are enabled to compute at once the calorific value of the gas.

Thermotwisters.

1. Convince yourself of the enormous amount of latent energy stored in 10 lb. of coal. Assume that each lb. of coal has a calorific value of 14,500 B.t.u. Convert into mechanical energy and estimate the vertical aerial journey you could take on this energy, were it exploded under you and your body were able to absorb all the energy.

2. In a heat engine test, each pound of steam leaves the engine containing 125.2 B.t.u. less heat than when it entered the cylinder. The engine develops 155 h. p., and consumes 3160 lb. of steam per hour. Compute the mechanical equivalent of heat.

3. In a test to determine the calorific value of anthracite coal by means of a Parr Calorimeter, ½ gram of the coal was properly burned and a temperature rise of 2.040° C noted. How many B.t.u. of heat per lb. of coal?

4. A piece of wrought iron bar, weighing one-half lb., is thrown into the furnace and heated to the temperature of the fire, and is then withdrawn and placed in a pail containing 10 lb. of water. The original temperature of water was 60 deg. F., and after the immersion of the iron, the temperature rose 20 deg. Find temperature of the furnace.

ELECTRICAL ACTIVITY IN NORTHERN CALIFORNIA.

A deal that gives the Siskiyou Electric Power & Light Company absolute monopoly of the water power resources of northern California and southern Oregon was made recently when the Rogue River Electric Company sold its light and power plants to the Siskiyou company for $3,300,000. Those concerned deny the merger is the work of the Western Power Company, the so-called power trust, of which Colonel Frank Ray, owner of the Rogue River Electric, is vice-president. It is known, however, that the Western Power Company has acquired control of pracitcally all the power plants in northern California, and that its eyes have been on Oregon. Owning power plants and controlling the power of Rogue River, Klamath River and the little Shasta River, besides that of smaller streams, the combination is the most gigantic ever made in this part of the State.

When the work now under way is completed this fall to a total of 80,000 horsepower at low water can be generated in this immense plant. Jesse W. Churchill, president, and J. P. Churchill, vice-president of the Siskiyou company, were the officials who met Colonel Ray. With the Churchills are Alex J. Rosborough and F. Detristan of Paris, representing a wealthy French syndicate.

SWISS AUTHORITIES ADOPT SINGLE PHASE SYSTEM FOR STATE RAILROAD ELECTRIFICATION.

In the Daily Consular and Trade Reports of August 28, 1911, the following statement in regard to the electrification of the Swiss State Railways appears:

"I am able to state on the highest possible authority that the report of the Swiss Commission which has been investigating the question of the electrification of the Swiss national railways will recommend the adoption of the overhead system similar to that which is now in use upon the London Bridge, Victoria & Crystal Palace Lines of the London, Brighton & South Coast Railway. This decision has been arrived at after a most careful comparison with the third-rail system as adopted upon the underground railways of London and other electric railways in this country.

The importance of electric railway working was fully recognized by the Swiss State authorities as far back as 1904, when a commission of 22 experts was appointed to study the matter. Up to the present time three reports have been issued by this commission; the first deals with the probable power requirements of the whole Federal system, consisting of 1830 miles; the second concerns the nature of the traffic, and the third deals with the most suitable system; that is, continuous current or alternating current. The report about to be issued will recommend the adoption of a single-phase, alternating current system with a pressure of 15,000 volts in the overhead wires. The first work to be taken in hand will be the conversion of the St. Gothard Railway, and comparative estimates have shown that the adoption of the third-rail continuous current system, so much in use in London, would involve a capital expenditure of about 8 per cent more than with the overhead system.

The total cost of conversion to electric traction upon the overhead system is estimated at $13,140,000, while the running costs are estimated at about 10 per cent less than the present cost with steam traction. Although no specific sums were mentioned in the Swiss budget for 1911 for the electrical equipment of railways, certain amounts were included for the acquisition of water power for the generation of the necessary electrical energy and also for further preliminary calculations and estimating work."

CENSUS RETURNS FOR POWER AND FUEL IN ARIZONA.

The increase in primary power from 1904 to 1909 was in power generated by steam engines, both water power and power generated by gas engines showing a decrease. However, a slight increase in the number of gas engines is shown, there being 31 such engines in 1909, as compared with 28 in 1904, although the total horsepower developed by them decreased from 1,392 in 1904 to 1,285 in 1909. The figures also show that the practice of renting power is on the increase, 6 per cent of the total power being rented in 1909, as compared with 1.9 per cent in 1904 and 0.4 per cent in 1899. The use of electric motors for the purpose of applying the power generated within the establishments is also shown to be increasing rapidly, the horsepower of such motors increasing from 496 in 1899 to 4,656 in 1904 and to 11,786 in 1909.

Closely related to the question of kind of power employed is that of fuel used in generating this power, or otherwise as material in the manufacturing processes. All industries in 1909 used 7,561 tons of anthracite coal; 69,256 tons of bituminous coal; 463,233 tons of coke; 14,558 cords of wood; 610,594 barrels of oil, including gasoline; 1,865,000 feet of gas; and 20 tons of other fuel.

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Traffic Expert for San Francisco

The congestion of traffic in the business centers of San Francisco has already become apparent, and it is most opportune that the Finance and Public Utilities Committee has decided to engage an expert with his corps of assistants to make a thorough investigation and recommendation for future improvements. At certain hours during the day the business of the great western metropolis has a tendency toward becoming paralyzed through lack of traffic facilities. If this is the case now, a situation of embarrassment is to be anticipated when the rush of exposition visitors and the enormous consequent increase in traffic arrives unless needed improvements and enlargements are undertaken at once. Bion J. Arnold, the well known municipal expert, has been engaged for this work. Mr. Arnold comes to this field loaded with experiences derived from similar investigations in a half dozen other great American cities, and the results of his efforts will be watched by all with great expectancy.

New Power Industries

It is interesting to note the new uses for electrical power in the west springing up about us almost daily. The housewife in thousands of western homes has long since found the electric iron, not only a convenience, but, when needed for short service, an actual economy. The recent experiments in orcharding in parts of the northwest, wherein electricity is made use of in combating the codlin moth, will be watched with considerable interest. Should it prove a success, thousands upon thousands of dollars annually spent in sprays and other chemicals will be diverted into revenue for the power plant. The sawmill was formerly thought to be the last stronghold of steam, but fortune is a cruel goddess, and we not only find electrically operated sawmills on the increase, but even the steam equipment in the logging camps is giving way to modern electrically driven machinery. The donkey engine, thought by all to be the one fortress to forever baffle economic electrical manipulation, is one of the latest conquests and will be found described elsewhere in these columns. The greatest field for future power uses, however, unquestionably lies dormant in the great undeveloped arid tracts of land awaiting water to make them yield the remarkable crops known only to Western soil. In the struggle and strife for water during the past years, engineers have schemed and planned gravity systems until, today, the number of combinations is about exhausted. Pumping plants must be the solution for the future. The State Engineer of Idaho estimates that there are in his State acreages by the millions that are susceptible of economic irrigation by this method. Similar conditions are to be found in other commonwealths of

the West. In Southern California where the combinations of gravity systems were long since exhausted, the new installations of electrically operated pumps have already swelled the power consumption of the Edison Company so that their power sales exceed their sales for lighting purposes. Thus hand in hand our western agricultural and power development will increase. Surely a great empire never offered a more flattering outlook for substantial growth.

Rating of Incandescent Lamps

There are in general two methods utilized in creating light by electrical energy—the electric arc and the incandescent lamp. In the incandescent lamp an electric current is passed through a solid conductor known as a filament, which is heated to incandescence by the electrical energy being dissipated as heat according to well-known physical laws. This filament is found to operate best where enclosed in a glass globe from which the air has practically been exhausted.

In order to make comparisons of one lamp with another, certain units of light output are necessary, as the ultimate aim of lamp manufacturing is to produce the most light for the least money. Lamps were first rated in watts consumed per mean horizontal candle power. This is not a strictly accurate or fair method, however, as horizontal candle power bears a variable proportion to the total light flow or flux for different makes of lamps. Hence the mean spherical candle power was adopted, which averages conditions, taking into account the entire amount of light emanating from the lamp. For instance, with the carbon filament lamp the reduction factor necessary to transform from mean horizontal to mean spherical candlepower is usually .79. Hence a sixteen candle power lamp has a mean spherical candle power of $16 \times .79 = 12.6$ c. p., and at an efficiency of 3.1 watts per horizontal candle power, has an efficiency of 3.92 watts per mean spherical candlepower.

It is interesting to note the progress in efficiency by scientific study and invention in the incandescent lamp industry. As an improvement over the carbon filament, first came the osmium lamp, which required but 1.5 watts per candle power. Since the entire world's supply of osmium would be exhausted in the lamp production of one year we cannot hope much from this quarter. Next came the tantalum lamp with an efficiency of about 2 watts per candle power, and finally the tungsten lamp with its efficiency of 1 to 1¼ watts per candle power. As tungsten metal has the highest melting point of all known metals, it can be operated at the highest temperature, consequently with the highest efficiency. In the busy struggle of competition the lamp companies have done much in educating the public to a fuller realization of economic methods of lamp use.

In our domestic life, after we have worn a suit of clothes for a time, some of us discard it at the change of the season, others upon its becoming glossy, others wait until the bottoms of the trousers become thread-bare, and still others have no definite point of abandonment, but wear it on and on to the discredit of our personal appearance and the amusement of our non-admiring friends. In a word the whole question of the proper time for putting on a new suit of clothes varies immensely with the individual, no definite cut-and-dried mathematical formula having ever been put forth. The particular time for a change is solved by the individual judgment of the user. Thus would have been uses in the lamp industry had it not been for the wide-awake lamp companies. The thousands of private homes would have continued to burn their lamps till the lamp became broken or the fancy of the user operated in a change.

Elsewhere in these columns will be found an article on the triple rating of lamps. It is shown that in general two factors enter into the cost of light, one the energy charge and the other the lamp charge. The former is an increasing direct proportion with watts per candle power, but the latter decreases with the same variable. Now then, by algebraically adding those two curves, point by point,, a third curve is deduced showing the absolute cost. This curve shows a definite point at which the cost not only ceases to decrease with watts per candle power but actually increases. This point is graphically determined by picking out the point in the third curve nearest the horizontal abscissa line. It is evident that upon the cost of power the steepness of the energy cost line will depend. Thus when power is cheap, this line will be comparatively flat. This in turn affects the total cost curve by making the minimum point further to the right, which evidently means that where power is cheap, low efficiency lamps are most economical and conversely where power is high, high efficiency lamps are by far the best to use. To meet these varying conditions of energy cost, a triple rating of lamps has been introduced by the lamp companies, so that purchasers may use lamps best adapted to this varying quantity.

As this educational campaign on the part of the lamp companies continues, more and more will the lamp users realize that not only definite voltages are best adapted for economic conditions, but, unlike the effect of the loosely drawn lines for discarding of clothes, the actual abandonment of lamps for new ones, at the arrival of the end of the definite useful period is a scientific economy and the more carefully attended to, the more money will it be in the pocket.

The electric lamp is today the means of lighting the millions of American homes. Its scientific study and economic use enters the inner vail of our home life. The educational campaign in behalf of its proper uses is due to the energy and enterprise of the American lamp companies and to them must be given all credit.

PERSONALS.

F. O. Sievers, of the Fort Wayne Electric Works sales force, is spending a vacation in the mountains.

S. N. Griffith, an electric railway promoter of Fresno, arrived at San Francisco during the past week.

C. R. Downs, the head of the waterworks system at Sutter Creek, was a recent San Francisco visitor.

Wm. Stranahan, manager of the Coalinga Water & Electric Co., was at San Francisco last week from Coalinga, Cal.

K. G. Dunn, engineer with Hunt Mirk & Co., returned to San Francisco during the past week, after a business tour of the Pacific Northwest.

W. J. Beck, an official of the New York Edison Company, who is touring the Pacific Coast, arrived at San Francisco during the past week.

William D. Ward, of the Pelton Water Wheel Company's sales force, has been visiting the Rocky Mountain region of the Northwest on hydroelectric business.

A. H. Halloran, managing editor of the Journal of Electricity, Power and Gas, is enjoying a few days' outing in Los Angeles, combining business with pleasure.

H. A. Lardner, manager of J. G. White & Co.'s Pacific Coast Branch, recently returned to his San Francisco headquarters after an inspection tour of Southern California.

Tracey E. Bibbins, of the General Electric Company's engineering staff, recently returned to San Francisco, after attending the National Electrical Jobbers' Convention in the East.

E. E. Trowbridge, an attorney of Los Angeles, whose advice has had much to do with the development of the Southern California Edison Company, recently spent a few days at San Francisco.

E. B. Strong, president and manager of the Technical Publishing Co., publishers of the Journal of Electricity, Power and Gas, after an eastern business trip covering several months, is again back at the San Francisco office.

W S. Woodridge, manager of the Pacific Coast office of Ford, Bacon & Davis, of New York, returned last Monday after inspecting the work in progress, on the Sierra & San Francisco Power Company's new dam on the Stanislaus River.

F. G. Baum, of F. G. Baum & Co., has secured a franchise for the erection and maintenance of poles, towers and electric transmission lines through Monterey County. The electric power line, which his company is constructing south from Salinas, has been completed for a distance of nine miles and will be extended to 70 miles.

A party of the Pacific Gas & Electric Company's engineering staff, including J. H. Wise, assistant general manager; J. P. Jollyman, the new engineer of electrical construction; and P. M. Downing, engineer of operation and maintenance of hydroelectric plants, have returned from an inspection tour of the hydroelectric developments in the Sacramento Valley district.

Ralph D. Mershon, of New York, is at San Francisco in charge of an exhaustive engineering investigation of the electric generating plants and electrical equipment of the local and suburban traction systems of the Oakland Railways Company, a subsidiary corporation of the United Properties interests. A great increase in the capacity of these plants will be necessary to provide for the projected extensions of the Key Route and Oakland Traction lines. It is understood that Mershon's report will be a basis for the future financing on a large scale for many contemplated improvements.

TRADE NOTES.

The Great Shoshone & Twin Falls Water Power Company, of Twin Falls, Idaho, has placed an order with the Westinghouse Electric & Mfg. Company for five 75 kva., 24000 volt, oil-insulated, self-cooled transformers.

The General Electric Company has sold to the Southern California Edison Company, one 2000 k.v.a., 500 r.p.m., 11,000 v., 3-phase, 50 cycle, 2 bearing, synchronous condenser, to be direct connected to exciter.

The Pacific Gas & Electric Company, of San Francisco, Cal., has recently placed with the Westinghouse Electric & Mfg. Company an order for ten 1000 kva., oil-insulated, self-cooled, tubular type, 11000 volt transformers.

Exhaust turbine generators have become a feature of the best sawmills in the State of California. The Yosemite Lumber Company which is building a large sawmill plant at Merced Falls, recently ordered from the Allis Chalmers Company a 450 kw. normal, mixed-pressure turbine generator set. A turbine condenser and auxiliary apparatus with switchboard complete, were also included in the contract.

The Brilliant Electric Company, 401 Electric Building, Cleveland, Ohio, has opened at 151 New Montgomery street, San Francisco, a branch office which will be in charge of Mr. E. D. Hand, the company's Pacific Coast representative. Orders for incandescent lamps received at the new office will be covered by prompt shipments from the neighboring warehouse at Oakland. Another "Brilliant" office has been opened in Los Angeles, California.

K. G. Dunn, with Hunt, Mirk & Co., is visiting San Diego, where his firm has been installing a 1000 kw. exhaust turbine generating set with Westinghouse reducing gear, which is the first of that type on the Pacific Coast. The Allis-Chalmers Corliss main engine was started up last week and the new turbine has since been turning over with everything working satisfactorily. Manager of Motive Power McNutt of the San Diego Electric Railway Company, has the supervision of the new plant.

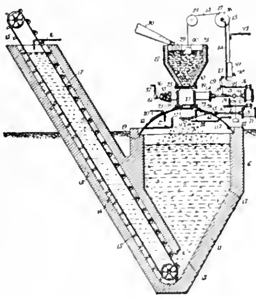
John S. Baker, who, for several years past, was at the head of the electric motor sales department of the General Electric Company, in this city, has been appointed District Manager of the Crocker-Wheeler Company's new Pacific Coast branch with headquarters at Room 400, First National Bank Building, San Francisco. Mr. Baker is well equipped for his position and will be prepared to reach out for business with a full line of alternating motors in addition to the a.c. generators formerly turned out by the Crocker-Wheeler factory.

NEW CATALOGUES.

The new 100-page catalogue of the Fostoria Glass Specialty Company entitled "Illuminating Glassware" lists, and illustrates by means of half-tone cuts, more than 1500 different styles of clear cut and etched globes, shades and reflectors for electric and gas lamps. In respect to the number of styles illustrated, this is probably the most comprehensive catalogue ever distributed by an American glass company; it is in fact a veritable reference work on the numerous schools of design and profusion of shapes exemplified in modern decorated illuminating glassware. The book itself is most attractively put together, and in spite of its scope is not at all unwieldly. It will be mailed gratis to persons interested in its contents from a commercial or professional standpoint. Applications should be made to the company's headquarters at Fostoria, Ohio, and should specify "Catalogue No. 52." "Iris," or iridescent glassware, is described in a separate publication by the same company.

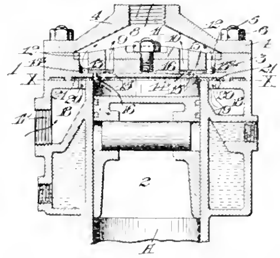
PATENTS

1,001,290. Steam-Generator. William E. McKee, Bisbee, Ariz. A steam generator comprising a container for water



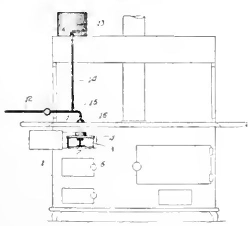
provided with a slag inlet, a valve controlling the slag inlet and means responsive to the flow of slag for controlling the operation of said valve.

1,001,305. Air-Compressor. Edward A. Rix, Oakland, Cal. In an air compressor, the combination of a cylinder having



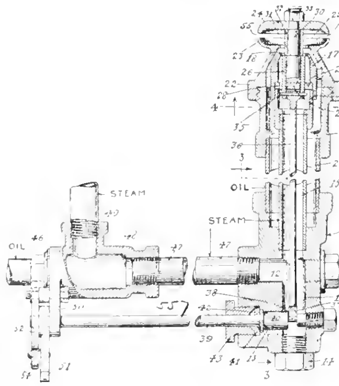
a head, said cylinder and head inclosing an annular valve chamber of larger diameter than the cylinder bore, said chamber having its inside periphery open directly to the cylinder bore, said cylinder having ports into said chamber, and a thin annular detached plate valve of greater diameter than the cylinder bore in the cavity operative puppet-fashion solely by the forces of gravity suction and compression to control said ports.

1,001,143. Oil-Burner. Fred Hendricks, Lodi, Cal. A device of the character described comprising the combination with a stove having a central orifice above the fire box,



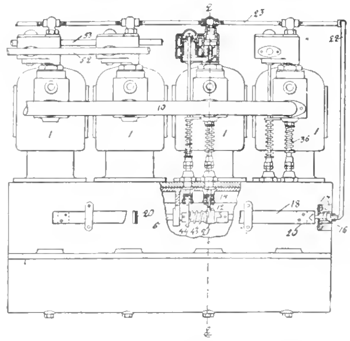
of a burner pan comprising a bottom member having an upwardly projecting flange all around its contour, further projecting side members centrally located on each side of said pan, a centrally orificed removable lid on said side members, a central pin projecting upwardly from the said pan, a cup-like receptacle on the lower end of said pin, an inverted cup-like receptacle on the upper end of said pin, said inverted receptacle having a plurality of orifices, a hood disposed over the orifice in said lid and projecting through the orifice in said stove, said hood having a plurality of recesses in its lower edge, an oil feed pipe discharging through said hood and said orifices in said stove and lid and on to said inverted cup-like receptacle, and a water supply pipe communicating with said oil pipe as described.

1,001,557. Hydrocarbon-Burner. Hiram C. Ruggles, Pasadena, Cal. A hydrocarbon burner, comprising a base member having a steam-way opening therethrough, a nozzle formed on the upper end thereof, a support mounted in said nozzle and extending therethrough, an inverted cup-shaped plate mounted on said support, an oil-way formed in said base member and terminating in the upper end thereof adjacent the



steam nozzle in a discharge orifice, said oil-way surrounding said steam-way, a cup-shaped chamber formed on the upper end of said oil-way adjacent said discharge orifice, said cup-shaped chamber forming with the inverted cup-shaped plate a mixing chamber, and means to regulate the size of the opening in the steam nozzle.

1,001,595. Internal-Combustion Engine. Szymon Jachimovicz, Berkeley, Cal., assignor of one-half to M. Grodin, Oakland, Cal. In an internal combustion engine having inlet and outlet valves and shafts rotating in fixed bearings, loose



cams on said shafts for controlling said valves in both directions of motion of said shafts, means for shifting the cams longitudinally upon the shafts, and means for shifting the cams circumferentially upon the shafts.

INDUSTRIAL

RECENT IMPROVEMENTS IN DISTRIBUTING TRANSFORMERS.

About three years ago such marked improvements were made in the design of single-phase distributing transformers that it was thought for a time that further improvements were practically impossible. These improvements were first embodied in the type S transformer developed by the Westinghouse Electric & Mfg. Company, East Pittsburg, Pa. They consisted principally in a radically new shell design of magnetic circuit whereby low magnetic reluctance is obtained without increasing the mean length of turn of the winding,

Fig. 1. Improved Transformer High Tension Coils Showing the Many Sub-divisions Used.

and which was especially adapted for the use of the new silicon steel for the magnetic circuit. These improvements resulted in a marked increase in efficiency, better regulation, and a reduction in exciting current, all important characteristics.

So radical were the changes made at that time that a large proportion of the electrical fraternity were led to feel that further increases in efficiency and exciting current were impossible. Nevertheless, development of the type S transformers has continued to progress and several marked improvements have been recently announced.

It is the belief of the designers of this line of transformers that this improved shell type of construction cannot be materially improved upon for distributing transformers of the 2200 volt class. The success of the large number of transformers of this type now in service supports this view.

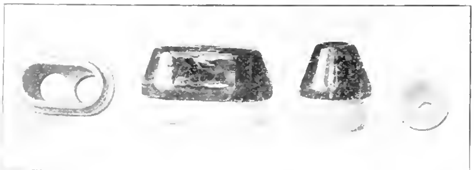


Fig. 2. Improved Transformer Bushings Showing Preventatives for Dust Collection.

The recent improvements have, therefore, resulted from improved materials and better mechanical design. The subject of insulation has been given special attention, as upon this the life of the transformer largely depends. The insulating materials now used are of better quality both mechanically and electrically, with the result that a further increase in efficiency and reduction of exciting current has been obtained. For example, the 7½ kva. type S transformer which formerly had an iron loss of 62 watts and copper loss of 125 watts, now has only 57 watts iron loss and 110 watts copper loss. The exciting current has been reduced from 2.2 per cent to 1.7 per cent, and the regulation at 100 per cent power factor improved from 1.69 per cent to 1.55 per cent. Other sizes show corresponding improved performance.

A very uniform temperature is maintained throughout the entire transformer and in no place does the temperature rise exceed 50 degrees under normal conditions. This insures long life and high all day efficiency.

In line with the question of insulation, the high tension coils have been further subdivided, to reduce the voltage between layers of the windings as well as between coils and thus relieve the strain on the insulation. A view of the improved coil is shown in Fig 1.

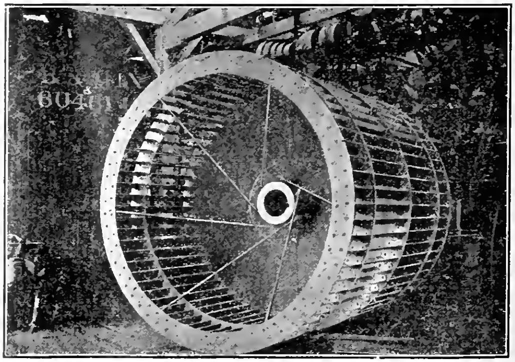
Slight changes have also been made in the terminal bushings to further prevent possibility of grounding to case due to the collection of dust between the bushing and the case and to still further make the siphoning of oil from the case impossible. The new bushing is shown in Fig. 2.

A highly flexible weatherproof cable is used for the leads of the type S transformer. These leads are rubber insulated with a grade of rubber that would deteriorate very slowly if exposed to the weather; the rubber insulation is protected by a braided covering. This cable meets the rigid new requirements of the National Board of Fire Underwriters, which some of the cables now used on transformers do not.

The manufacturers of the type S transformer announce that they do not believe a transformer incapable of further improvement will ever be built, and that therefore it is their intention to continue the development of this line, even though they consider it already ahead of anything on the market.

VENTILATION PENNSYLVANIA RAILWAY COMPANY, BALTIMORE AND POTOMAC TUNNEL, AT BALTIMORE, MARYLAND.

The Pennsylvania Railway Company are installing a very large ventilating plant in one of the tunnels under the City of Baltimore. This tunnel has a length of 4963 feet with a cross sectional area of 432 sq. ft. The crown of the tunnel is

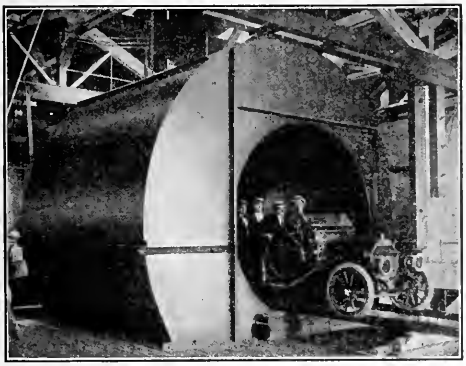


Wheel of Sirocco Fan for Ventilating Baltimore & Potomac Tunnel.

19 feet high above the rails at the portals and the cubic feet of space from end to end amounts to 2,150,000.

The fans discharge downward through the floor into a chamber surrounding the upper part of the tunnel, the air being discharged from the chamber through a long tapering nozzle carried around the entire perimeter of the tunnel above the tracks in such a way as to direct the flow of air forward much the same as it would from an injector.

The fan wheel or impeller is 10½ feet in diameter and breadth, with a division plate, dividing the breadth of it into two halves, air entering from both sides. The relative proportions of this fan wheel is more readily apparent in the photograph where it is shown near the end of a box car. It will be noticed that it is about as high as the car, is 50 per cent wider and almost half the length of it.



Housing of Sirocco Fan for Ventilating Baltimore & Potomac Tunnel.

Only one of these fans is intended to be in operation at a time, the other being held in reserve for use in case of accident.

It was determined that this tunnel would require 450,000 cu. ft. of air per minute. This volume will produce a velocity through the tunnel of 1040 feet per minute or at about the rate of 12 miles per hour and will give an air change in 4¾ minutes, or, in other words, a unit of volume starting at one end will be only 4¾ minutes in passing through the tunnel.

When a train is going through the tunnel in the same direction as the air current, the available area for the passage of air being so greatly reduced, causes the air to travel much faster than the train; hence, any smoke from the locomotive is pushed before the train so fast as to give the engineer a clear view of the tracks, thereby enabling him to easily stop the train in time to avoid accident. The movement of air is so rapid as to make it perfectly comfortable for the passengers and train crew at any and all times, even if the train comes to a dead stop for a prolonged period.

While these fans are of huge proportions, yet they are small as compared with the dimensions of an old-style fan to do the same work, such as was commonly used for the same purpose before the "Sirocco" fan was invented.

Charles S. Churchill, chief engineer of the Norfolk and Western Railway Company, Roanoke, Va., designed the plant where these fans are to be installed, as he has several others, notably the Galetzin, Bid Bend and Elkhorn tunnels for the Pennsylvania Railway and the Norfolk and Western Railway. Previous to the installation of the ventilating plant at the Elkhorn tunnel at Coaldale, W. Va., on the Norfolk and Western Railway, it required from 17 to 55 minutes to clear the tunnel of smoke; the temperature inside the tunnel became about 30 degrees higher than the outside temperature after a train had passed through, and during the four years immediately preceding the installation of the ventilating plant, twenty-six men were asphyxiated in the tunnel.

After the installation of the ventilating plant, smoke would appear at the portal ahead of an engine two minutes before the train appeared and in less than a minute after the engine had passed out, even the steam had vanished from the roof where it usually clings so persistently.

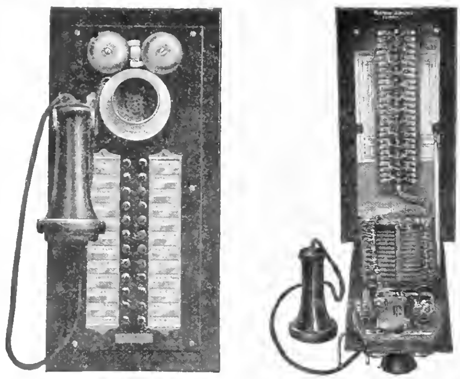
Eastbound, trains which have to run up grade now, pass through the tunnel in 5½ minutes, and one train can follow the other as rapidly as it is safe to place them, regardless of the tunnel.

The installation of this ventilating plant made it possible to increase the load of eastbound trains about 100 tons, saving four eastbound trains per day on a run of eleven miles, which represents a net saving over and above the cost of operation of about fourteen hundred and forty-six dollars per month, or from seventeen to twenty thousand dollars per year.

The "Sirocco" Fan, made by the American Blower Company of Detroit, Michigan, and Troy, New York, is unquestionably the greatest advance made in air-propelling machinery in the last century, and of itself has attracted more general attention to the use of fans for ventilation and the benefits to be derived from good, fresh, pure air than probably any other agent, because of the small size of the fan for a given duty, its remarkably high efficiency and very quiet operation.

A NEW METAL FLUSH TYPE OF INTER-PHONE SET.

The Western Electric Company has added to its many types of inter-phones a new metal flush set, which on account of its handsome appearance, convenience of installation, compactness and general efficiency, represents the highest type of inter-communicating telephone for residence work. This set, known as the No. 1335-type, is made in capacities for 12, 16 and 24 stations, the one shown in Fig. 1 being a 24-station type.



No. 1335-F Inter-phone Set. Interior and exterior Views.

One of the features of this set is the metal outlet box which is separate from the set and can be built in the wall while the house is in process of construction. All the apparatus is mounted on a face plate, which is hinged at the bottom so that connections in the outlet box are easily accessible when the face plate is removed.

While the set is compact, it is not crowded, and a concealed binding post receiver adds to its neat appearance. Conversations between pairs of stations at the same time are perfectly quiet, that is, there is no evidence of the annoying interference known as cross talk. As many conversations can be carried on at once as there are pairs of stations.

By winding the coils of the vibrating bells to 10 ohms, the current necessary to ring long or short lines is more nearly equalized. A high resistance transmitter and receiver are used with the set which insures low battery consumption.

NEWS NOTES

FINANCIAL.

MYRTLE CREEK, ORE.—The city is to bond itself to the extent of $20,000 at the next meeting of the council to provide funds for the laying of a pipe line to a stream two miles from town, where a dam is to be constructed to supply the city with water.

SAN FRANCISCO, CAL.—H. P. Wilson, secretary of the Great Western Power Company, and of the California Electric Generating Company, a subsidiary company, has called meetings of the stockholders on October 26, at room 1012, Shreve Building. An increase in the capitalization of the parent company from $25,000,000 to $27,500,000 will be considered. A proposition to make dividends on the stock of the subsidiary company cumulative after January, 1912, will be brought before the stockholders, as also the desirability of a contract for power with the City Electric Company and the guaranty by the California Electric Generating Company of the payment of the interest upon $1,700,000 bonds of the City Electric Company.

SAN FRANCISCO, CAL.—A suit to bring about the reorganization of the San Francisco, Vallejo & Napa Railroad Company has been filed in the office of the county clerk of Napa County, by the Mercantile Trust Co. of San Francisco. The complaint says that on October 22, 1906, the defendant executed a mortgage to the British American Trust Company, as trustee, to secure the payment of 1500 bonds for $1000 each. Later the company defaulted on its interest, and on July 13, 1911, the Mercantile Trust Company was chosen as a new trustee of the mortgage. The electric railroad company has filed its consent to the proceedings of foreclosure. The reorganization will leave the company in better financial condition than before.

LOS ANGELES, CAL.—A meeting has been called for October 9 by Chas. Forman secretary of the Pacific Light & Power Company, at which the stockholders of the company will consider the issuing of bonds to the amount of $35,000,000 in addition to its outstanding issues of $5,000,000 in collateral trust 6 per cent 5 year gold bonds. Of this $35,000,000 there will be set aside $9,015,000 to take care of the underlying bonds of the corporation and $3,000,000 authorized to protect the holders of the bonds of the Southern California Gas Company, a subsidiary concern. Bonds to the amount of $10,000,000 have already been contracted for in New York to carry on the construction of the great plant on Big Creek, and in the construction of the distributing plants in the San Joaquin Valley and other portions of Southern California. The remainder of the bonds, nearly $13,000,000, will be sold and the proceeds expended in future extensions, which the corporation is planning. The plant under construction on Big Creek will develop 80,000 h.p., with an ultimate capacity of 150,000 h.p. by enlargements at a later date.

ILLUMINATION.

LA MESA SPRINGS, CAL.—The San Diego Land Improvement Company is planning to establish a gas plant at Encanto to make gas from gasoline and distribute it in mains sufficient to supply residents on the tract.

RIVERSIDE, CAL.—A. N. Kemp, second vice-president and controller of the Southern California Gas Company, states that gas pipes will be laid soon. The plan in contemplation is to belt the city with high pressure pipes and feed from them into low pressure mains through automatic regulators.

ELLENSBURG, WASH.—Ordinances ordering a municipal water system for Ellensburg and calling for an election for the purpose of ratifying an issue of $110,000 of electric light bonds has been passed by the council.

VICTORIA, B. C.—The city council will shortly formulate plans for extending the cluster lighting system on View street. Provisions will be made for laying conduits for arc lighting wires in the James Bay district.

SACRAMENTO, CAL.—Work of laying its cross-city conduit which will run from Seventh and M to Seventh and I streets, will be commenced immediately by the Citizens Light & Power Company, according to President George W. Peltier. He says: "We are going to use the latest type of steel conduits and will bury them about 4½ feet under the surface. The poles in the resident district also, will be placed in alleys. We now have a sub-station, at Eighth and R streets, which regulates the amount of power we receive from the station at Brighton. Power will be conducted from the Eighth and R station by the Seventh street conduit and from this main line wires will radiate east and west through the alleys into all sections of the city. We are already supplying many with power along R street."

INCORPORATIONS.

SALEM, ORE.—The Hermiston Telephone & Electric Company, Hermiston, has been incorporated with a capital stock of $7000.

BAKERSFIELD, CAL.—The Bakersfield Gas & Electric Light Company has been incorporated by H. A. Jastro, H. A. Blodget, L. C. McAfee, L P St. Clair, and C E. Jewett, with capital stock of $100,000.

BOISE, IDAHO—Articles of incorporation have been filed for the Mountain States Telephone & Telegraph Co., E. B. Field, Pres., capitalized at $50,000,000. This company is a consolidation of the Colorado Telephone Co. and the Tri-State Telephone & Telegraph Co., and will carry on a general telephone and telegraph business in Idaho, Montana, Arizona, Colorado and other states with principal offices at Denver, the lines to extend from that city to territory named. King Cobbs, 511 Bannock street, Boise, Idaho, is the Idaho agent.

TRANSMISSION.

WASHOUGAL, WASH.—Sam Samson has applied for a franchise to extend his high voltage electric wire through this town and county to Vancouver, a distance of 60 miles.

KELSEYVILLE, CAL.—James A. Gunn, Jr., has applied for a franchise for a period of 50 years, to erect and maintain poles, upon county roads for the purpose of transmitting electric power and heat.

LOS MOLINOS CAL.—A representative of the Sacramento Valley Power Company is making a thorough canvass of the farming district around this city for the purpose of making contracts for light and power with the farmers. It is understood that the Northern Electric Company will soon have a man in the field for the same purpose.

COLUSA, CAL.—That the people of Williams will have electricity for light and power shortly is now assured. The

Supervisors have granted a franchise to the Northern California Power Company, and E. V. D. Johnson, manager of the company, was in Williams recently making necessary arrangements for the completion of the line to that town. The power company will have its main office in Colusa County and will also have an electrical supply store where electric fixtures will be demonstrated to the public. Jerry Myers, of Willows, who has been superintending the work in Williams, will be the local manager in the latter town, it is said.

SACRAMENTO, CAL.—What is considered an attempt to gobble up the entire water supply flowing in or out of Cowshed lake, Modoc County, was unearthed yesterday by the conservation board of control in the water filing of George B. Ayers. Ayers' filing is for 5,000,000,000 cubic feet of water, which is a record breaker for the State. The filing was made Feb. 7, 1911, before the conservation laws went into effect. Whether Ayers intends to use the water for irrigation purposes or is to hold it for speculative play is a question the board expects to determine

LONG BEACH, CAL.—All preparations are practically completed for the first run of the initial unit of the Southern California Edison Company's new power plant in process of installation on Long Beach Harbor. All the machinery is in working order except some minor parts, which are essential, however, to its operation, such as disconnecting switches. Construction is rapidly proceeding upon additional units to go into commission as soon as they are completed. Each is of a capacity of 12,000 kw. and an official of the company stated this morning that no decision as to the limit in their number has been reached the site and franchises secured being of such proportions as to permit of the erection of a plant sufficient in size to meet all the power demands of Southern California.

NEVIS, CAL.—The Great Western Power Company on the north fork of the Feather River, will build at a point two miles below the Big Meadows, in Plumas County, one of the most expensive dams in the country for the storage of water in the Big Meadows, which is the headwaters of the North Fork of the Feather River. By building this great dam the company will overflow about 25,000 acres of land at an average depth of 25 feet. By tests made with a diamond drill at this point it is found that the company will have to make an excavation about 500 feet below the surface to reach a solid foundation from which to commence this work. It will be seen then that most of this great piece of work is to be below the present surface, the dam itself above the surface being only 150 feet high. It will be many hundred feet long on top. The company has been very active this year in the preliminary work leading up to the road work construction. Several hundred men are now employed in this preliminary work.

SACRAMENTO, CAL.—Arrangements for the examining of applications for the appropriation of waterpower in accordance with the new law have been made by the Conservation Board of Control. The members present were C. D. Marx, S. C. Graham and State Engineer N. Ellery. Secretary Louis R. Glavis said that the new blanks on which the applications are to be made will be ready for use within ten days. Glavis stated that ten applications for the appropriation of waterpower had already been made. One of the first that will be acted upon is that of Los Angeles city in connection with the $23,000,000 Owens River aqueduct project. The application made in behalf of Los Angeles by Chief Engineer William Mulholland asks for waterpower appropriation for 1500 inches on the Cottonwood Creek, 2078 feet of head water for Cottonwood Creek power house, No. 3, 2197 feet for Cottonwood Creek power house, No. 2 and 1218 feet for Cottonwood Creek power house, No. 3. The application also includes data regarding the construction of the two gigantic reservoirs included in the general project.

TRANSPORTATION.

BOISE, IDAHO.—The Nampa & Caldwell Electric Company will construct a railway. A contract will soon be let.

LOS ANGELES, CAL. The work of constructing an electric line to El Segundo will be started within a few days. This is the new Standard Oil town.

RAYMOND, WASH.—Sanderson & Porter, contractors, have started construction work on an electric railway between this place and South Bend. The right of way is being cleared.

CHICO, CAL.—The Board of Trustees has passed an ordinance granting permission to George E. Springer to construct and operate a railroad over certain streets in the city of Chico.

LOS ANGELES, CAL.—Contracts will be let next week for building an electric railroad connecting San Bernardino and Riverside, by the Pacific Electric Company. This line will be about 7 miles long, but includes heavy construction and a long trestle bridge over Santa Ana River. The line has been surveyed and will be built from San Bernardino to Rialto.

VANCOUVER, B. C. The Canadian Electric Construction Company has applied for a franchise to construct a tram line across Stanley park. The proposal was referred to a commissioner, who will have power to act.

EUGENE, ORE.—Mr. Kruttschnitt, head of the departments of maintenance and construction of the Harriman lines, states that there is every indication that the Southern Pacific Railway will electrify its west side lines into this place via the town of Corvallis.

SOUTH PASADENA, CAL.—Work is expected to start within a few days on the new freight and passenger station which the Pacific Electric Company will erect on Mission street, just east of Fair Oaks. It will be of Mission style architecture and cost $10,000.

SANTA BARBARA, CAL. San Luis Obispo officials have granted Walter Gould Lincoln of Los Angeles, a franchise for the construction of an electric road from San Luis Obispo to the coast. This will probably be extended eastward through the mountains to Bakersfield and Fresno.

PETALUMA, CAL.—The Petaluma & Santa Rosa Railway Company has commenced a suit in the Superior Court of Sonoma County against Henry Poehlmann, Geo. P. McNear and others to condemn a right of way for that road along the west side of Petaluma River and south from the city.

PORTLAND ORE.—Two electric lines may be operating between Portland and Eugene before the end of the coming year—one an extension of the Oregon Electric and the other an extension of the Southern Pacific's Corvalis line. The Oregon Electric project already has been planned and actual work on its construction awaits only the arrangement of details. While the Southern Pacific has not officially announced its intention to connect Eugene with Portland by means of an electric line every indication points in that direction and actual developments of the last few months seem to bear out the theory.

SAN FRANCISCO, CAL.—Work has started on the east portal of the Oakland-Antioch Electric Railway Company's tunnel connecting Alameda County with Contra Costa county. The west portal will open into Oakland at a point within 200 yards of the easternmost limits of the city. Completed the tunnel will be about 4000 feet in length. At the present time the Oakland-Antioch has trains running into Walnut Creek from Bay Point in Contra Costa County. Rails are

being laid into Lafayette. It is from the latter place the last lap of the electric railway is being run a distance of 18 miles. When completed the Oakland-Antioch will have a trackage of 50 miles, the distance from Bay Point into Oakland.

TELEPHONE AND TELEGRAPH.

NEWPORT, WASH.—J. W. Fisher, manager of the Interstate Telephone Company, is applying for a telephone franchise in this city.

TRUCKEE, CAL.—The telephone lines of the Pacific Telephone & Telegraph Company between Camptonville and Loyalton will be rebuilt.

BOISE, IDAHO.—A. R. Johnson has been appointed as Idaho agent and Lewiston as headquarters in Idaho, of the Pacific Telephone & Telegraph Company.

ALICEL, ORE.—Cove and Alicel have had a meeting for the purpose of formulating plans to organize a co-operative telephone company in Wallowa and Union counties.

BELLINGHAM, WASH.—The Farmers' Mutual Telephone Co. has opened offices in the Daylight building. The local office will handle all the company's outside business.

KALISPELL, MONT.—The Columbia Falls Telephone Association, capitalized at $40,000, has been incorporated by C. C. Miller and H. E. Kennedy. The company contemplates the installation of telephone lines all over this county, with headquarters at Columbia Falls, Mont.

ABERDEEN, WASH.—Plans and specifications for the new building to be erected by the Pacific States Telephone & Telegraph Company, on Market street, have been completed by Architect Watson Vernon. This is to be a three-story brick and concrete building, to cost $30,000.

MEDFORD, ORE.—C. H. Moore, of Portland, district superintendent of the Pacific Telephone & Telegraph Company announced that his company will, within a short time, start work on an additional cable estimated involving an expenditure of between $15,000 and $20,000.

WATERWORKS.

BURLINGTON, WASH.—Burlington is to have a water system. A pumping plant is to be installed.

BREWSTER, WASH.—This place at a recent election voted bonds for the construction of a water system.

FALLS CITY, ORE.—This place will soon vote on bonds for a $5000 bond issue, to extend the local water main system.

ELLENSBURG, WASH.—A special election was held September 4th to decide on a $150,000 bond issue for the construction of a municipal water system.

CENTRALIA, WASH.—Meetings are being held in an endeavor to further the interest of establishing a gravity water system to serve this place and Chehalis.

GLADSTONE, ORE.—The election providing for the issuance of bonds in the sum of $20,000 for the construction of a water system has been carried by 28 majority.

ELMA, WASH.—Citizens of Elma have petitioned the council to allow the citizens to vote a $10,000 bond issue for the purpose of extending and improving the water system.

CARLTON, ORE.—An election has been carried in favor of bonds in the sum of $40,000 for the purpose of constructing a new water system. The water will be brought from Panther creek. A fall of 200 feet can be secured.

TENINO, Wash.—The City Council has granted a franchise to the Tenino Light, Power and Water Co. to erect, maintain and operate a system of waterworks for the town.

ASOTIN, WASH.—The council has passed an ordinance providing for the issuance of bonds in the sum of $35,000 for the purpose of constructing a water system according to plans by C. H. Green, on file in the office of the town clerk.

DORRIS, CAL.—Notice is given by the town of Dorris, County of Siskiyou, State of California, that it will receive sealed proposals to build the Dorris Water Works system up to September 4, 1911.

WAPATO, WASH.—This city is to have a water system according to plans filed in the office of the Auditor of Yakima County, also in the office of the town clerk. Pipe ranging in size from 6 to 10 inches; estimated cost $17,000.

OAKLAND, CAL.—The first work of laying the 6-inch water mains in the annexed district west of Fitchburg was started yesterday by the Union Water Company, when a force of men were set to work distributing the mains along Peralta street.

MARSHFIELD, ORE.—At a meeting of the water commissioners of Marshfield and North Bend, Stannard & Richardson of Portland were engaged to prepare plans and estimates of the cost of a municipal water system for the two cities.

SAN FRANCISCO, CAL.—Engineers Sloan & Robson, 802 Nevada Bank Building, have prepared plans for the drilling of two 12-inch wells which are to form a part of the city water system of Tracy. Bids for this work were opened on August 31.

HERMINSTON, ORE.—An election has been carried in favor of the issuance of bonds in the sum of $25,000 for installation of a water system. The system calls for a 250,000 gallon reservoir 140 feet above the city, the water to be brought down in a 12 inch main.

PILOT ROCK, ORE.—Representatives of the C. H. Green Company of Portland, Ore., visited Pilot Rock and after a short consultation with members of the council entered into a contract with the city for a complete survey and estimate of the cost of a waterwork system.

ASOTIN, WASH.—The council has passed an ordinance providing for the construction of a waterworks system for Asotin to cost $35,000, payment to be made by issuance of a $35,000 bond issue, denomination of $1000, payable 20 years from date, interest 6 per cent per annum.

WENATCHEE, WASH.—O. A. Hoag has started excavating at the lower end of Lake Chelan, preliminary to his project to develop the water power of Chelan Falls. A contractor and crew will soon lay pipe and the town of Chelan has granted right of way for this purpose.

TACOMA, WASH.—City Electrician B. W. Collins states that the local light and power lines will have to undergo a complete change and be completely re-organized to care for the electricity to be developed by the Nisqually municipal power plant, which will be completed July, 1912.

VANCOUVER, B. C.—Upon the recommendation of the city engineer, the city of Vancouver is within the next six weeks to lay a sixth additional 12-inch main under Burrard Inlet at the First Narrows, the pipe having been ordered and the location for the main selected. It is proposed, also, to provide another intake at Capilano Creek and more mains across the inlet, although a large reservoir at Little Mountain will be ready to be cut into the system of the city within the course of a year, greatly increasing the supply of water.

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AN ELECTRIC GAS METER TEST

BY J. C. WILSON[1]

While Professor Carl C. Thomas of the University of Wisconsin was making his investigations on the specific heat of superheated steam he made use of an electric heater as a means of introducing a measurable amount of heat into flowing steam. The weight of steam flowing per unit of time could easily be obtained by condensation and weighing. By measuring the rise in temperature produced in a measured quantity of steam by a measured quantity of heat the specific heat of the steam was directly obtained. During these experiments it occurred to him that if a measurable amount of heat could be added to a superheated gas having a known specific heat and the resultant temperature change could be measured the weight of gas would be directly obtainable, that is, he would have a meter. From this idea has developed a new and novel meter which will actually weigh air or gas at it flows through a pipe.

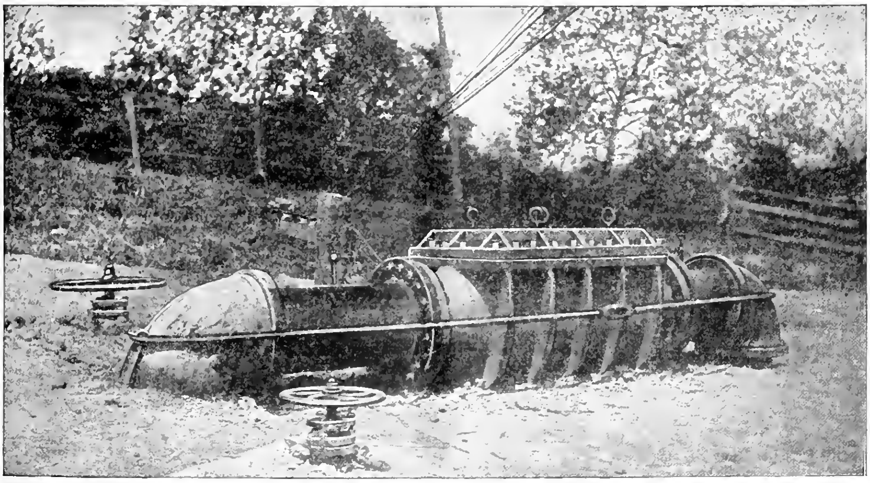

Fig. 1. Casing of Electric Gas Meter Installed in a Natural Gas Line.

This fundamental property of measuring the quantity of matter flowing per unit of time instead of the volume that this matter occupies under some certain conditions of pressure and temperature makes this meter especially applicable to a very broad field of measurement. It can be used for measuring ventilating air at low pressure or compressed air used in the various industries, natural gas with its very high pressures, or artificial gases in any condition of pressure and temperature, and in all of these cases give continuous graphical or integrated results directly in any standard unit which is based upon the quantity of stuff contained in it.

A meter that could be used for so broad a service seemed well worth developing into a commercial form. The first meters were designed for the introduction into the flowing gas of a constant supply of heat, which was accomplished by passing electric current through a resistance material evenly distributed over the section of the passage. The resultant rise in temperature was measured and recorded by means of a temperature difference recording device operated in connection with resistance thermometers

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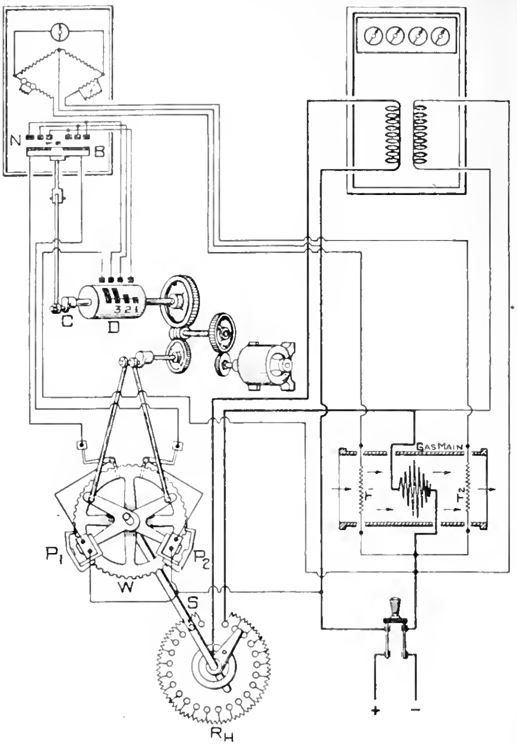

Fig. 2 Diagram of Electric Gas Meter Connections.

unit in the gas main. Since the specific heat of any given gas is constant under all working conditions of temperature and pressure, the temperature rise caused by a constant heat supply was inversely proportional to the rate of flow of gas. The temperature difference recorder was arranged to read in standard cubic feet instead of in degrees of temperature difference. This design had some disadvantages. A constant supply of electrical energy to a heater is not a simple problem commercially, and although temperature differences can be measured and recorded very accurately, the results were obtained by an inverse proportion instead of a direct one and they could not be integrated. However, it was one of the steps through which all devices must pass in their development and some very valuable results were obtained with this type of meter as will be explained later.

It was soon seen that if the temperature increase could be kept constant and of a known value for all variations in rate of flow, the amount of heat energy required to maintain this constant temperature increase would be directly proportional to the rate of flow. Since this heat is furnished in the form of electrical energy it could be measured by means of a wattmeter and if it could be automatically regulated to maintain a constant temperature increase in the gas, the problem of a successful commercial meter would be solved. Either a graphical or integrating wattmeter or both could be used and they could be made to read directly in standard units of gas instead of in watts. The problem of automatically regulating the heater energy to maintain a constant temperature increase was worked out as follows:

Referring to Fig. 2, the two thermometers T_1 and T_2 are made two arms of a Wheatstone bridge. These thermometers are on opposite sides of the heater unit and consist of a resistance material evenly distributed over the section of the pipe. This resistance material has a positive temperature coefficient, that is, it increases its resistance with an increase in temperature. The other two arms of the Wheatstone bridge are fixed coils of resistance wire having a zero temperature coefficient. Across the bridge is a galvanometer of the flat coil type so arranged that any unbalancing of resistances in the bridge causes a deflection of the needle. The bridge operates on a balanced condition and it remains balanced so long as the flow of gas remains constant. The deflections of the galvanometer needle caused by changes in rate of flow are utilized to regulate the heater energy so as to restore the bridge to its balanced condition.

In series with the heater is a rheostat R_h on the shaft of which is a toothed wheel W. The deflections of the galvanometer needle N must be made to move this wheel. As this needle has no power of the magnitude required to do this work a small continuous running motor is arranged to furnish this power. Through gears and eccentrics this motor causes the two pawls P and P_1 to move with a vertical reciprocating motion through an arc equal to the length of three teeth. These pawls are pulled into engagement by means of magnets. The motor also drives a

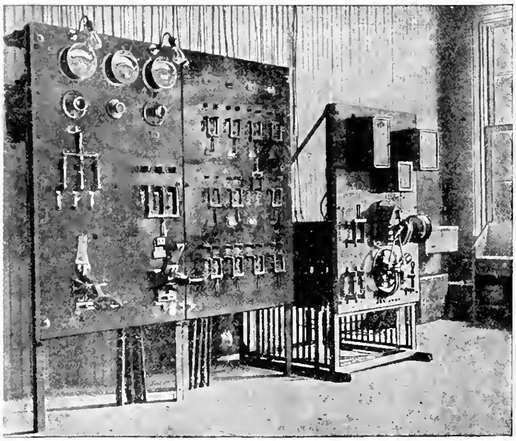

Fig. 3. Meter Recording Panel Installed Alongside of Switchboards in the Generator Station.

crank C which causes the needle to be clamped periodically between two sets of contacts. On the crank shaft is a drum carrying segments of different lengths. If the needle should be clamped in its extreme right hand position the pawl P_1 would be pulled in by its magnet to engage the toothed wheel at the bottom of its stroke and it would remain engaged throughout its upward stroke, thus moving the rheostat arm three steps. If the needle is clamped one division

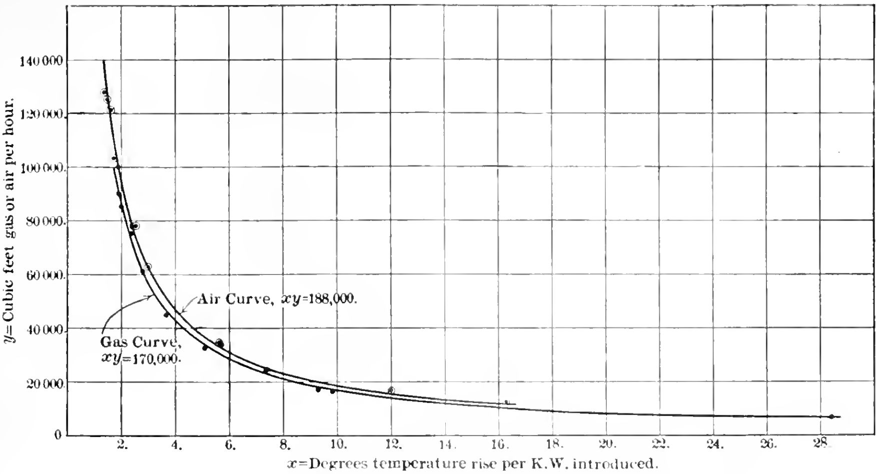

Fig. 4. Curves for Test of Thomas Meter Against Wet Displacement Meter.

to the right of its central position the pawl is engaged only during the last one-third of its stroke and the rheostat arm is moved one step. Thus a small or large increase or decrease in the rate of flow of gas causes the heater energy to be increased or decreased a corresponding amount so as to maintain the temperature increase constant.

With the heater current broken and with gas flowing through the meter so that the two thermometers have the same temperature, the galvanometer is balanced by means of a small rheostat in series with the exit thermometer. The entrance and exit thermometer circuits then have the same resistance. A resistance is then inserted in the T_1 circuit equal in value to the increase in resistance in thermometer T_2 corresponding to a temperature change of about two degrees F. The heater current is thrown in and the control device automatically increases the heater energy until the bridge again balances, that is, until thermometer T_2 has been brought to a temperature two degrees higher than T_1 and this balanced condition is maintained in spite of variations in rate of flow. Since the increase in temperature is thus maintained a constant the value of which is determined by the amount of the temperature difference resistance inserted in series with the entrance thermometer, it only remains to measure the electrical energy supplied to the heater in order to have a direct measure of the rate of flow of gas. This is accomplished with a commercial wattmeter.

The heater and thermometer units are mounted in a sheet metal barrel and this barrel is in turn inserted in a cast iron casing designed to suit any desired pressure. (See Fig. 1). A gas jacket is provided to reduce radiation losses to a minimum. From this casing the electrical connections lead to the recording panel having mounted on it the automatic control device, the regulating rheostat, and the recording instruments. (See Fig. 3).

1. Laboratory Tests.

Very extensive tests were made on the electric type of meter against the Pitot Tube and the Venturi Meter in the Gas Engineering Laboratory of the University of Wisconsin. In these tests all three meters were inserted in series in the same pipe

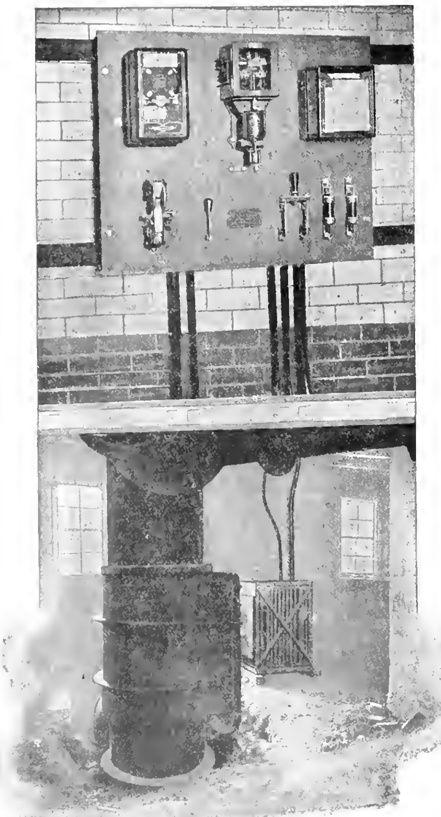

Fig. 5. Thomas Meter Installed in Basement of Pumping Station with Recording Panel on Main Floor Above.

line and air was passed through them at different rates of flow. The meters were all of the very simplest form and the electric meter was arranged to give indicated results only. It was manually controlled and the observations were taken on an indicating wattmeter. These three meters were appli-

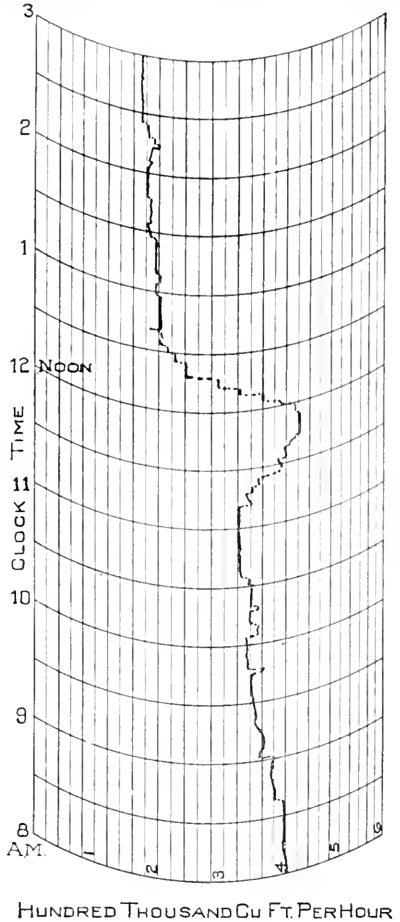

Fig. 6. Record Made by New Meter Shown in Fig. 5 on Which is Seen the Noon Peak Load in a City's Gas Supply.

cations of three fundamentally different principles. Independent observations were very carefully made for each and the calculations were made from fundamental theories only. We have space here only to note that these three different methods of measuring a common quantity gave results that differed from each other by very small percentages throughout the range of flow. These tests established beyond a doubt the soundness of the fundamental principles of the electric meter and also brought out very clearly the ease of taking observations and obtaining results with this method as compared with the other two. They also emphasized the possibility of developing by the electric method a meter that will automatically give continuous graphical or integrated results directly in standard cubic feet that compare very favorably with those obtained with the other two methods by careful observations and laborious computations.

2. Tests Against Wet Displacement Meter.

During the early development work an electric meter was tested in series with a wet displacement meter for the measurement of illuminating gas in the Milwaukee Gas Light Company's Works. Both gas and air were passed through the two meters in series so that direct comparisons could be obtained. The electric meter was of the constant energy variable temperature type and was arranged to record the the amount of temperature rise at the different rates of flow corresponding to a constant energy input

If E = kilowatts supplied to the electric meter.
G = cubic feet of gas flowing per hour.
T = temperature rise in the gas in degrees F.
S = Specific heat of the gas in B.t.u. per cubic foot.

Then $E \times 3412 = G\,S\,T$ and $G \times \frac{T}{E} = \frac{3412}{S} =$ constant.

Therefore if we plot values of G in cubic feet per hour obtained by the wet meter as ordinates and corresponding values of $\frac{T}{E}$ obtained from the electric meter as abscissas, the resultant curves must be rectangular hyperboles. Fig. 4 shows the points plotted for both the gas and air tests with rectangular hyperbolas drawn through them. From the gas curve

$$G \times \frac{T}{E} = 170{,}000 = \frac{3412}{S}$$

and S, the specific heat of the gas, as found to be 0.0201. Similarly the specific heat of air computed from the air curve = 0.0181. The conditions of the gas and air during the tests were as follows:

	Gas	Air
Temperature, Fahrenheit	50	60
Pressure, Inches Water	6	6.5
Barometer	29.8	29.75

Reducing the values of specific heat obtained from the tests as shown above to standard conditions of 32 degrees F. and 29.9″ mercury, S for the gas becomes 0.0210 which is to be compared with the specific heat computed from the analysis of the gas given below.

	Vol. cu. ft.	Weight per cu. ft. lb.	Total Weight lb.	Specific Heat per lb.	Specific Heat per cu ft.
CO_2	0.04	0.11637	0.004658	0.216	0.00100
C_2H_4	0.11	0.0741	0.00815	0.404	0.00329
O_2	0.001	0.08463	0.00085	0.217	0.00023
CO	0.331	0.07407	0.02450	0.245	0.00600
CH_4	0.1761	0.04234	0.00746	0.593	0.00442
H_2	0.303	0.00530	0.00160	3.409	0.00546
N_2	0.0389	0.07429	0.00289	0.244	0.00071
					0.02111

Similarly the specific heat of air reduced to standard conditions of 32 degress and 29.9″ mercury becomes S = 0.0191 which is to be compared with the generally accepted value of 0.0192 B.t.u. per cubic foot for air under these conditions. These tests, especially those with air whose specific heat is well known, provide very good evidence of the accuracy of the electric meter as compared with the wet displacement meter which is generally accepted to be most accurate and reliable for artificial gas measurement.

Fig. 5 shows a typical installation of the commercial electric meter for the measurement of illuminating gas. This meter installed in the pumping station of the Milwaukee Gas Light Company, measures all of the gas supplied to the City of Milwaukee. It has a maximum capacity of 3,000,000 cubic feet of free gas per hour. Fig. 6 is a portion of graphical chart made by this meter showing the shape of the peak curve in the city's supply caused by the increased demand for gas for cooking purposes at noon.

3. Tests Against Pitot Tube With Natural Gas.

Fig. 1 shows a meter installed at the Brave Pumping Station of the Peoples Natural Gas Company of Pittsburg for the measurement of natural gas between the wells and the pumps. The casing is located in a field just above the level of the ground immediately between two elbows and close to gate valves and is in a 10-inch suction line within about 200 feet of the suction header of the pumping station. From this casing the electric connections lead to the recording panel installed alongside the switchboards in the lighting plant from which the meter receives its supply of energy. (See Fig. 3). This meter has a maximum capacity of 750,000 cubic feet of free gas per hour and an accurate minimum capacity of 12,500 cubic feet. It is designed to give a graphical record as well as integrated values of flow directly in standard cubic feet at 15.025 pounds pressure and 60 degrees F. although the pressure of the gas in the line varies from 50 to 200 pounds gauge and the temperature varies with weather conditions. The specific heat of the standard unit was computed for the design of the meter from an analysis assumed from an average, and to correspond to the standard pressure and temperature stated above.

This installation afforded an unusual opportunity for checking the accuracy of the meter on account of the very wide and rapid variations in the pressure and rate of flow of the gas in the ordinary operation of the system, and also because there was installed at Bula a very complete and thoroughly calibrated Pitot Tube Station, one tube of which was in the same line with the Thomas meter. The two meters could thus be run in series although they were separated by about one and one-half miles of 10-inch pipe. Readings of pressure and velocity head were taken on the Pitot tube every fifteen minutes day and night, and from these readings values of gas flow in standard cubic feet were obtained by the use of carefully prepared tables. Since these tables reduced the Pitot Tube readings to the same standard units in which the Thomas Meter was designed to read, the results were directly comparable.

Very thorough tests were made on the Thomas meter under service conditions to determine the degree of accuracy with which it would give continuous results directly in standard cubic feet with variable pressures, temperatures, and rates of flow, as compared with the results obtained by very frequent and careful observations on the Pitot tubes, and also to learn whether all the parts would stand up satisfactorily against wear and the action of the gas.

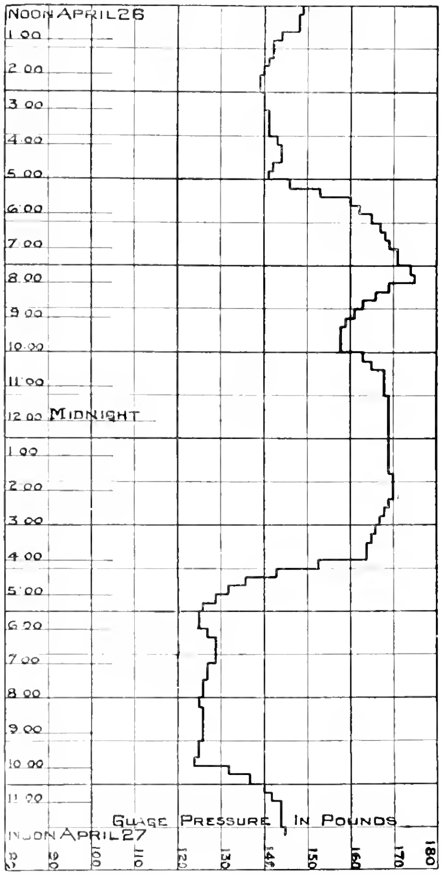

Fig. 7. Pressure Log for 24-hour Period of Test on Thomas Meter with Natural Gas.

HOURLY RESULTS OF 22-HOUR TEST OF THOMAS METER.

Hour	Cubic Feet Each Hour: Chart	Cubic Feet Each Hour: Integrating Meter	Cubic Feet Each Hour: Pitot Tube	Total Cu. Ft. at end of Each Hour: Chart	Total Cu. Ft. at end of Each Hour: Integrating Meter	Total Cu. Ft. at end of Each Hour: Pitot Tube
8-9	397,500	400,000	400,297	307,500	400,000	400,297
9-10	398,500	398,000	394,027	796,000	79" 000	794,324
10-11	370,000	374,000	373,731	1,166,000	1,172,000	1,168,055
11-12	376,500	377,000	380,800	1,542,500	1,549,000	1,548,855
12-1	361,500	364,000	367,726	1,904,000	1,913,000	1,916,581
1-2	370,900	377,000	377,694	2,274,900	2,290,000	2,294,275
2-3	381,200	387,500	386,103	2,656,100	2,677,500	2,680,378
3-4	380,900	386,500	387,815	3,037,000	3,064,000	3,068,190
4-5	382,600	384,000	387,229	3,419,600	3,448,000	3,455,419
5-6	385,510	388,000	389,052	3,805,110	3,836,000	3,844,471
6-7	391,250	388,000	392,161	4,196,360	4,224,000	4,236,652
7-8	395,000	391,000	394,654	4,591,360	4,615,000	4,631,286
8-9	394,500	392,000	392,416	4,985,860	5,007,000	5,023,702
9-10	397,500	398,000	392,245	5,383,360	5,405,000	5,415,947
10-11	387,000	383,000	385,383	5,770,360	5,788,000	5,801,330
11-12	388,000	387,000	387,104	6,158,360	6,175,000	6,188,434
12-1	378,000	373,000	386,983	6,536,360	6,548,000	6,575,417
1-2	439,500	436,000	435,416	6,975,860	6,984,000	7,010,833
2-3	447,000	446,000	445,945	7,922,860	7,430,000	7,456,778
3-4	463,000	459,000	465,896	7,885,860	7,889,000	7,922,674
4-5	465,000	464,000	467,240	8,350,860	8,353,000	8,389,914
5-6	407,500	411,000	394,886	8,758,360	8,764,000	8,784,800

The above table shows the hourly results of a comparative test of twenty-two hours duration. During a large part of this test the rate of flow was kept nearly constant and the temperature of the gas remained about the same but the pressure varied

from 72 to 123 pounds gauge. The values of cubic feet for each hour are obtained from the chart by averaging the curve traced by the meter, from the integrating meter by subtracting the reading at the beginning of the hour from that at the end, and from the Pitot tube in the manner described above.

After this test the meter was put into continuous service in series with the Pitot tube and it ran with but very few interruptions in the gas flow for forty-five days. Readings were taken on the Pitot tube as before and results were obtained from the Thomas meter by means of the continuous records and by reading the integrating instrument at intervals of three hours. The following is a sample log sheet for a twenty-four hour period of the test:

24-HOUR LOG OF TEST OF THOMAS METER, BRAVE, PA. NOON APRIL 26th TO NOON APRIL 27th, 1911.

Time	Integrating Meter Reading	Cu. Ft. Integrating Meter	Cu. Ft. Chart	Cu. Ft. Pitot Tube	Pressure Brave	Pressure Bula	Temperature Brave	Temperature Bula
12:00	2498.0							
3:00	2603.6	1,056,000	1,030,800	1,056,536	134	140	47	46
6:00	2714.3	1,107,000	1,073,400	1,115,176	157	161	47	43
9:00	2831.7	1,174,000	1,134,000	1,160,802	156	160	47	43
12:00	2965.0	1,333,000	1,321,200	1,311,671	162	167	47	43
3:00	3086.7	1,217,000	1,230,600	1,226,774	162	166	47	42
6:00	3215.0	1,283,000	1,302,900	1,310,577	114	124	47	40
9:00	3375.0	1,600,000	1,631,400	1,614,811	113	125	47	40
12:00	3523.2	1,482,000	1,479,000	1,480,000	135	143	47	46
Totals	......	10,252,000	10,203,300	10,276,350				

Fig. 7 shows the variations in pressure during the same twenty-four hours as plotted from observations made at the Pitot tube. During the 45-day test the pressure varied from 46 to 185 pounds gauge, the temperature from 45 to 65 degrees F. and the rate of flow from 90,000 to 640,000 cubic feet per hour. The presence of several thousand feet of 10-inch pipe line, the sudden changes made in the control valves sometimes at Brave and sometimes at Bula, and the sudden increase or decrease of pressure over quite wide ranges during certain periods, all tended to cause slight differences in the results as shown by the two meters during short periods of time. That these slight differences were averaged out over longer periods is shown by the following summary of the two tests:

28-HOUR TEST, APRIL 9th AND 10th, 1911.

Total standard cubic feet of gas for 22 hours by Pitot tube 8,784,800

Total standard cubic feet of gas for 22 hours by Thomas meter 8,764,000

$$\frac{8{,}784{,}800 - 8{,}764{,}000}{8{,}784{,}800} = 0.2\% \text{ difference.}$$

ENDURANCE TEST APRIL 17th TO JUNE 3d, 1911.

Total standard cubic feet of gas by Pitot tube...... 337,546,182

Total standard cubic feet of gas by Thomas Meter.. 336,732,018

$$\frac{337{,}546{,}182 - 336{,}732{,}018}{337{,}546{,}182} = 0.2\% \text{ difference.}$$

In order to make the test complete and the results more conclusive an analysis of the gas was standard cubic foot was computed from this analysis. Although the actual composition of the gas was found to be considerably different from that assumed for the design of the meter, the values of specific heat as computed from the two analyses are almost identical.

After the tests were computed the heater and thermometer units were removed from the casing and thoroughly inspected. They were found to be in perfect condition and the only deposits to be found anywhere inside the casing were a very thin coating of fine dark brown powder, almost dry and a few finely divided pieces of scale. The recording instruments and control device were also found to be in perfect condition.

These tests have proved conclusively that the Thomas meter will give under widely varying conditions of pressure, rate of flow, etc., direct results in standard units that compare most favorably with those obtained from frequent and careful observations on Pitot tubes and the use of tables and coefficients that have been very carefully checked. The particular property of the electric meter by virtue of which it will measure gases at any pressure and temperature and give direct readings in standard units in spite of variations in pressure and temperature make it applicable to the measurements of compressed air used in the mines and other industries.

Conditions Which Affect Accuracy.

Since measurement by this method depends directly upon the specific heat of the gas, the accuracy of the meter will be affected by any conditions that affect the specific heat. The specific heat of a gas may be affected by the presence of water vapor, by a change in the proportions of its constituents, or by a change in the proportions of a mixture of two kinds of gases. That it is not affected by changes in temperature or pressure within working limits is not only in accordance with established theory but it has been proved in the tests with natural gas already described.

Air and most gases which need to be measured contain water vapor in varying amounts. As the amount of vapor that a gas will hold at any temperature and pressure is independent of the kind of gas, air may be taken as a typical case. At 60 degrees F. and at atmospheric pressure air will hold, if it is fully saturated, 5.6 grains of water vapor per cubic foot. The weight of the mixture of air and vapor is about 533 grains. Then the water might amount to about 1.05 per cent of the weight of the air. As the specific heat of water vapor is approximately twice that of air the maximum error that could occur due to the presence of the water vapor would be

Date	CO_2	C_nH_{2n}	O_2	CO	H_2	CH_4	N_2	CP	BTU	Sp. Gr.	Sp. Ht.
June											
11	3.4	9.2	0.4	11.0	37.2	32.9	5.9	21.8	703	.518	0.2168
12	3.5	9.7	0.4	9.8	36.6	33.2	6.8	22.9	710	.522	.02174
14	3.4	10.2	0.4	10.0	36.3	33.6	6.1	22.9	724	.523	.02182
15	4.0	10.0	0.4	10.6	35.8	32.5	6.7	21.4	708	.535	.02180
16	3.5	9.3	0.4	10.2	38.3	31.9	6.4	21.6	696	.512	.02167
17	3.4	9.6	0.2	10.0	36.7	34.6	5.5	20.9	724	.515	.02182
18	3.6	10.0	0.4	10.0	37.2	32.3	6.5	21.5	709	.521	.02173
19	4.0	9.6	0.2	10.6	34.5	34.0	7.1	22.1	712	.540	.02182
21	3.8	9.7	0.2	10.0	35.6	33.7	7.0	21.7	712	.531	.02182
22	3.7	9.7	0.4	10.2	37.2	32.9	5.9	22.0	710	.519	.02174
Avg.	3.63	9.70	0.34	10.24	36.54	33.16	6.39	21.88	710.7	.5236	.02176

Mean of ten values of specific heat computed from individual analyses, .02176.

Maximum variation of specific heat computed for individual analyses from the specific heat computed fro the average analyses, 0.4%.

about 1 per cent. Since the humidity of air is seldom lower than 50 per cent the variation in its specific heat would be much less than 1 per cent. Should it be desirable to make corrections for this small error they can be made from the tables for saturated gases on the basis of an assumed or an ascertained humidity. If the gas to be measured is over saturated, and water is carried along mechanically as a fog or mist, the evaporation of this by the heater energy of course interferes with making accurate measurements. This difficulty can be easily overcome by heating the gas slightly above the temperature of saturation before it enters the meter.

The variations in composition of gases which we need most to consider in relation to their effect upon the specific heat are those which occur in the mixtures of two different kinds of gases. The following table, copied from a paper by Mr. E. C. Jones in the Proceedings of the American Gas Institute for 1909, shows the variation in composition from day to day of mixed crude oil gas and carburetted water gas. To this table have been added the computed values of specific heat in B.t.u. per pound per degree F. for a cubic foot of gas at 14.696 pounds absolute pressure and 60 degrees F.

This table indicates that the results obtained from a meter designed on the basis of the average analysis would be subject to a maximum error during any day of a small fraction of one per cent and that this error will be averaged out in longer periods of time.

From the table given below showing the computed values of specific heat for different mixtures of coal and water gas it is seen that the effect upon the specific heat of the variations in the mixtures of these gases that occur under working conditions is negligible.

Water Gas.	Coal Gas	Specific Heat.
100%	0%	.02094
90	10	.02096
80	20	.02098
70	30	.02100
60	40	.02102
50	50	.02104
40	60	.02106
30	70	.02110
20	80	.02110
10	90	.02112
0	100	.02114

These values of specific heat are in B.t.u. per degree F. for a cubic foot of gas at 14.804 pounds absolute pressure and 60 degrees F. They are based upon the following two typical analyses for water gas and coal gas in a city plant..

	Water Gas.	Coal Gas.
Co_2	3.8	2.2
C_nH_{2n}	12.3	3.3
O	0.6	0.5
CO	30.4	6.9
H	33.3	50.6
CH_4	14.4	34.2
N	5.2	2.3

Where a meter is an important feature of a gas distribution system it is periodically inspected and it is very desirable to be able to ascertain whether the parts inside the gas main are in proper condition. Since the electric meter has no moving parts inside the gas main the only effects which the action of the gas can have on the inner parts are those due to deposits or corrosive actions on the heater and thermometer units. Since the watts dissipated in the heater, as measured by the wattmeter, are a product of current flowing through the heater and voltage across its terminals, their measurement is independent of the resistance or surface of the heater unit itself and therefore cannot be affected by either corrosion or deposits. Should excessive deposits occur on the units they would only tend to make them slower in following sudden changes in flow. Provision is made for checking the condition of the thermometers from the recording panel without removing the cover from the meter casing. With gas flowing through the meter the heater current is broken and the temperature resistance in series with the T_1 thermometer is shorted out. If the thermometers are in proper condition the galvanometer needle will come to a balance. If the thermometer circuits do not thus balance a small rheostat is provided in the galvanometer box to bring them back to a proper balance. Thus the only parts of the meter which can be affected to cause inaccuracies of measurement can be checked up from the recording panel as often as desired.

The heater and thermometer resistances are evenly distributed over the total section of the gas passage so that all of the gas is heated and a correct average temperature difference is obtained regardless of variations in velocity at different parts of the section. On this account it is possible to obtain accurate results without providing a long length of straight pipe in the approach to the meter. This was proved in the natural gas tests already described in which the meter was located directly between two risers from an underground line and very close to several bends. On account of the slight heat capacity of the heater and thermometer units they will not change their temperatures instantly and therefore quick pulsations in the rate of flow are averaged out and do not show up in the record. The integrating wattmeter also correctly integrates periodical fluctuations in the rate of flow.

Working Range and Flexibility of Parts.

The working range between maximum and minimum rates of flow at which the electric meter will measure accurately is about 14 to 1. By changing the temperature range through which the gas is heated, which is accomplished by shifting a resistance plug at the recording panel, the meter will measure accurately down to a minimum rate of about one and one-half per cent of the maximum. This wide working range combined with the ability to make an accurate continuous graphical record of the rate of flow makes possible investigations of the shape and magnitude of peak loads and other irregularities in flow.

As shown by Figs. 2, 3 and 5 the arrangement of parts of the meter is very flexible. The meter casing may be in either a horizontal or a vertical position and the recording panel can be located at almost any desired distance from the meter, since the connections between them are all electrical and therefore perfectly flexible. In meters of very large capacity where the rheostat becomes quite large the recording instruments and control switches may be put on a separate panel and the rheostat put in any convenient location. It will also be noted that the design lends itself very easily to a remote control from gate valves, etc., in the gas main.

ELECTRICAL APPLIANCES FOR WESTERN CANADA.

Within a few months the city of Winnipeg will be prepared to sell electrical energy. Its great plant at Point du Bois, costing $2,250,000, and capable of generating 100,000 horsepower, is rapidly nearing completion; and the business men of Winnipeg, as well as householders generally, are looking forward with keen anticipation to cheaper power. While the city is contemplating purchasing the street car system, it may develop during negotiations that it will take over the power plant of the street railway company, which supplies not only power for the railway, but also furnishes electricity for private lighting, as well as for commercial power.

The rates for power at present are as follows: 6 cents per watt-hour up to 50 horsepower; 4 cents per watt-hour over 50 to 100 horsepower; 3 cents per watt-hour over 100 horsepower. Private lighting costs 10 cents per kilowatt; electricity for cooking costs 6 cents; gas, $1.20 per 1,000 feet.

Public lighting, which is done by tne city electric-lighting plant, costs an average of 11 cents per arc lamp per night, the total cost in 1910 being $42,977.

USE OF HERTZIAN WAVES AS FOG SIGNALS.

As far back as 1908, at the Eighth International Navigation Congress held in Paris, the Lighthouse Department of France has had in mind the employment of Hertzian waves for the production of fog signals.

The Minister of Public Works has now decided that the time is a fitting one to proceed with the installation of suitably chosen Hertzian posts, which may be increased as they are needed and as improvements are made.

The characteristics of the three new signals will be as follows:

Creach d'Ouessant lighthouse: A fog signal with the regular emission every 30 seconds of signals producing in the telephone the note "ut 4" (522 double vibrations per second), and arranged so as to repeat, at least during 10 seconds, slowly, the letter "o" of the Morse alphabet.

Ile de Sein lighthouse: A fog signal with the regular emission every 30 seconds of signals producing in the telephone the note "sol 4" (783 double vibrations per second), and arranged to repeat slowly, during at least 10 seconds, the letter "s" of the Morse alphabet.

On board the lightship Le Havre (in constructions): A fog signal giving ,with a wave length of 80 meters (262 ft.) the regular emission every 30 seconds of signals producing in the telephone the note "ut 4," and arranged so as to repeat slowly, during 10 seconds at least, the letter "h" of the Morse alphabet.

PHILIPPINE ELECTRIC LINE.

The long-looked-for and much-desired Manila street railway extension to the new docks will be realized in a short time, according to a statement made by General Manager Graves, who announces thas his company is ready to begin the extension work, which will be undertaken as soon as the Government gives its consent.

ELECTRICAL MACHINERY AND APPARATUS.[1]

The electrical industries have had a most remarkable development during the past decade. The value of the machinery and apparatus manufactured for use in the generation and utilization of electricity increased from $105,832,000 in 1899 to $159,551,000 in 1904, and $243,967,000 in 1909, or 130 per cent during the decade. Large quantities of supplies used for electrical purposes are manufactured in foundry and machine shops and other establishments not identified with the electrical industries. These parts are assembled by dealers and others not covered by the census, and it is impossible to obtain accurate information in regard to them. Therefore, the totals given above are less than the true value of all of the machinery of this character manufactured annually in the United States.

The value of products represents their selling value or price at the plants as actually turned out by the factories during the census year, and does not necessarily have any relation to the amount of sales for that year.

Dynamos.

Dynamos, dynamotors, motor generators, and similar machines constitute the most important generic group of electrical machinery. The number of dynamos manufactured annually increased from 10.527 in 1899 to 15,080 in 1904, and 16,791 in 1909, an increase of 59 per cent for the decade. The value of the dynamos for each year was $10,473,000, $11,084,000, and $13,081,000, respectively. As a rule much larger and more powerful dynamos were manufactured in 1909 than for the prior years, so that while the average value of machines manufactued was greater in 1909, they represented a lower cost for corresponding capacity. The average capacity per machines, increased from 55 kilowatts in 1889 to 66 in 1904, and 84 in 1909. The value of the dynamotors, motor generators, boosters, rotary converters ,and double currrent generators manufactured increased fom $380,000 in 1899 to $3,155,000 in 1909, or 730 per cent.

Transformers and Switchboards.

The value of transformers manufactured increased from $2,963,000 in 1899 to $4,469,000 in 1904, or 51 per cent, and to $8,801,000 in 1909, or 197 per cent. The value of the switchboards, panel boards, cut-out cabinets for light and power increased from $1,847,000 in 1899 to $3,766,000 in 1904, or 104 per cent, and to $5,972,000 in 1909, or 223 per cent.

Motors.

The total value of motors of all kinds, including supplies and parts, manufactured increased from $19,505,000 in 1899 to $22,371,000 in 1904, and $32,087,000 in 1909, or 64 per cent for the decade.

The number of power motors manufactured annually increased from 35,604, valued at $7,551,000, in 1899 to 79,877, valued at $13,121,000, in 1904, and to 244,123, valued at $18,306,000 in 1909, there being an increase of 586 per cent in number and 142 per cent in value for the decade. Many powerful motors were manufactured, but the number of small motors has increased so rapidly that the average capacity per machine has declined, the average horsepower per motor

[1]Preliminary Report for 1909, issued by the Census Bureau

for the three census years being 14.5, 8.5, and 6.7, respectively.

Tabular Summary.

The following statement summarizes the statistics for the principal products as reported at the censuses of 1909, 1904, and 1899:

In 1899 there was great activity in the manufacture of motors for automobiles, but the increase in this branch of industry has not kept pace with that for other classes of electrical equipment. The number manufactured decreased from 3,017 in 1899 to 1,879 in 1904, with an increase to 2,796 in 1909. On the other hand, the capacity of motors reported increased 4,251 horsepower, or 52 per cent, during the decade, and the value of these motors has increased from $192,000 in 1899 to $153,000 in 1904, but increased to $294,000 in 1909.

The number of small motors for the operation of fans has increased very rapidly. There were 97,577 such motors reported in 1899. In 1904 there were 102,535, and in 1909, 199,113, an increase of 104 per cent for the decade. The value of these motors increased from $1,055,000 in 1899 to $2,451,000 in 1909, or 132 per cent.

The statistics of motors for electric railroad cars cannot be shown separately without disclosing the products of individual establishments, but there was a considerable increase in the manufacture of such motors as compared with the production of 1904, which was 12,298, of 713,181 horsepower, valued at $4,950,000. Considering the group of motors for cars, elevators, and similar purposes, the combined number decreased from 23,582 in 1899 to 22,112 in 1904, and increased to 58,698 in 1909. The value of these motors was $10,707,000 in 1899, $7,929,000 in 1904, and $11,036,000 in 1909, there being an increase of 149 per cent in number and 3 per cent in value during the decade, the decrease shown for the group in 1904 being entirely due to the decrease in the manufacture of railway motors at that census.

Storage and Primary Batteries.

The value of the storage and primary batteries manufactured increased from $3,679,000 in 1899 to $4,244,000 in 1904 and $10,612,000 in 1909, or 188 per cent during the decade. Both storage and primary batteries consist of various elements which are not always combined and sold together as a unit by the same manufacturers, and yet it is not until these are brought together that a complete cell is constituted. Many of the parts and supplies used are manufactured outside of the electrical field, and therefore the statistics shown in this report do not convey a correct idea of the importance of this branch of the industry.

Arc and Incandescent Lamps.

The number of arc lamps manufactured increased from 158,187 in 1899 to 195,157 in 1904, and decreased to 123,543 in 1909. The decrease is accounted for by the fact that other varieties of lamps are now used for street light and for other purposes for which arc lamps were formerly used almost exclusively. The value of these lamps deceased slightly in 1904 ($1,574,000) as compared with 1899 ($1,828,000), but owing to the introduction of more types of these lamps, such as flaming arcs, increased to $1,707,000 in 1909.

The group of incandescent lamps includes carbon filament, gem, tantalum, tungsten, glower vacuum, vapor and similar lamps used for lighting, advertising and decorative purposes. Some of these varieties were not manufactured in 1899 or 1904. A large number of decorative and miniature lamps, X-ray bulbs, vacuum tubes, etc., are now manufactured, but the varieties are so numerous that it is impossible to obtain accurate statistics of the number. The total value of the group increased from $3,515,000 in 1899 to $6,953,000 in 1904 and $15,715,000 in 1909. The value of the carbon filament lamps increased rapidly from 1899 to 1904, but there was a slight decrease in 1909, the value for the respective years being $3,442,000, $6,308,000, and $6,157,000. The manufacture of gem, tantalum, tungsten, and other metal filament lamps was reported separately for the first time at the census of 1909, when they were valued at $7,682,000. Some of these new variaties of lamps were not reported separately at prior censuses, and it is possible that they were included with the carbon filament lamps, thus accounting in part for the apparent decrease in that variety of lamp. Advertising, decorative, and all other lamps, including in 1909 glower lamps, vacuum and vapor lamps not separately reported in 1904, have increased in value from $645,000 in 1904 to $1,876,000 in 1909.

The total value of all lamps reported for 1909 was $15,715,000. This does not include sockets, receptacles, bases, etc., or lighting fixtures of any character.

Lighting Fixtures.

The value of electric-light fixtures of all kinds manufactured in 1899 was $3,751,000; in 1904, $3,295,000; and in 1909, $6,128,000. Large quantities of combination gas and electric fixtures are now manufactured. At the census of 1909 it was ascertained that the value of these combination fixtures was about $12,884,000. Their value for prior censuses cannot be ascertained, and there were undoubtedly large quantities manufactured in connection with the manufacture of gas fixtures which are not identified with the manufacture of electric supplies, and their value is not included in this report.

Telegraph and Telephone Instruments.

The telegraph instruments include intelligence (key, sounder, etc.) of all kinds, police, fire, district, and miscellaneous instruments, wireless apparatus, also switchboards and telegraph parts and supplies. The total of this group of instruments in 1899 amounted to $1,642,000, in 1904 to $1,111,000, and in 1909, $1,957,000, an increase of 19 per cent in the decade.

Telephone apparatus includes transmitters, receivers, complete sets of instruments (not included in the separate parts), interior telephone systems complete, and central switchboards, private exchange boards, parts and supplies. The total value of this group in 1889 was $10,512,000 as compared with $15,864,000 in 1904, and $15,547,000 in 1909, a slight decrease during the last five-year period.

The report also shows the value of the total annual output of miscellaneous apparatus used in connection

with the utilization of electric current. Principal among these may be mentioned electric measuring instruments, the output for which in 1909 was $7,800,000; magneto-ignition apparatus, sparks, coils, etc., valued at $6,080,000; electric switches, signals and attachments, $5,384,000; heating, cooking, and welding apparatus, $1,003,000; lightning arresters, fuses, etc., valued at $1,942,000; theraputic apparatus, $1,116,000; circuit fittings, $1,081 000; and electric flatirons, $951,000.

ELECTRICAL MACHINERY, APPARATUS AND SUPPLIES—PRODUCTS, BY KIND, QUANTITY, AND VALUE: 1909, 1904, AND 1899

ITEMS.	1909	1904	1899
Number of establishments	[1] 1,255	[1] 912	[illegible]
Total value of products	$243,967,000	$159,551,000	$105,8[illegible],000
Dynamos:			
Number	16,791	15,080	[illegible]
Total kilowatts	1,105,951	906,182	[illegible]
Value	$13,081,000	$11,084,000	$10,473,000
Dynamotors, motor generators, boosters, rotary converters and double-current generators	$3,155,000	$1,740,000	[illegible]
Transformers for light and power	$8,801,000	$4,409,000	$2,[illegible]
Switchboards, panel boards, cut-out cabinets for light and power	$5,972,000	$3,7[illegible],000	$1,847,000
Motors.			
For power—			
Number	241,123	79,877	[illegible]
Horsepower	1,62[illegible]	678,910	[illegible]
Value	$18,[illegible],000	$13,121,000	$7,[illegible]
For automobiles—			
Number	2,79[illegible]	1,[illegible]	3,017
Horsepower	12,471	19,[illegible]	[illegible]
Value	$294,000	$15[illegible],000	$19[illegible]
For fans—			
Number	194,113	102,[illegible]	97,577
Horsepower	178,0[illegible]	30,[illegible]	12,[illegible]
Value	$2,151,000	$1,16[illegible],000	$1,[illegible]
For railways, elevators, and miscellaneous services, including supplies and parts—			
Number	[illegible]	22,112	27,[illegible]2
Horsepower	[illegible]	[illegible]	[illegible]
Value	$11,6[illegible],000	$7,[illegible],000	$10,707,000
Storage batteries, including parts and supplies			
Weight of plates in pounds	23,119,[illegible]	10,113,073	(2)
Value	$4,178,000	$2,[illegible],000	$2,[illegible],000
Primary batteries including parts and supplies			
Number	34,33[illegible]	[illegible],102	2,[illegible]
Value	$[illegible],931,000	$1,[illegible],000	$1,119,[illegible]
Arc lamps:			
Number	123,643	[illegible],177	1[illegible],137
Value	$1,707,000	$1,[illegible]1,000	$1,[illegible],000
Searchlights, projectors, and focusing lamps	$936,000	$115,000	$220,[illegible]
Incandescent lamps.			
Carbon filament, gem, tantalum, tungsten lamps	$13,5[illegible],000	$6,[illegible],000	$3,412,000
Decorative and miniature lamps, X-ray bulbs, vacuum tubes, etc. (also includes glower lamps and parts, and vacuum and vapor lamps).	$1,876,000	$[illegible]	$73,000
Sockets, receptacles, bases, etc	$[illegible]	$[illegible]	$[illegible]
Electric lighting fixtures of all kinds	$[illegible],128,000	$3,[illegible]	$3,751,000
Telegraph apparatus	$1,[illegible],000	$1,111,000	$1,[illegible]
Telephone apparatus	$15,547,000	$[illegible],364,000	$10,[illegible]
Insulated wires and cables	$[illegible]	$[illegible]	$[illegible]
Electric conduits	$[illegible]	$[illegible],416,000	$1,[illegible]
Annunciators—Domestic, hotel, and office	$[illegible]	$[illegible]	$[illegible]
Electric clocks and time mechanisms	$372,000	$[illegible]	$1,[illegible]
Fuses	$1,[illegible],000	$[illegible]	$[illegible]
Lightning arresters	$940,000	$[illegible]87,000	
Rheostats and resistances	$2,67[illegible],000	$[illegible]	$1,1[illegible]
Heating, cooking, and welding apparatus.	$1,003,000	$[illegible]6,000	
Electric flatirons	$951,000	(2)	[illegible]
Electric measuring instruments	$7,800,000	$[illegible]	$1,542,000
Electrical therapeutic apparatus	$1,116,000	$1,037,000	(2)
Magneto-ignition apparatus, sparks, coils, etc	$6,080,000	$[illegible]	(2)
Electric switches, signals, and attachments	$5,384,000	$[illegible],000	$1,[illegible]
Circuit fittings of all kinds	$1,081,000	$[illegible]	(2)
All other products	$[illegible]	$2[illegible]	$15,[illegible]
Amount received from custom work and repairing	$5,[illegible]	$2,7[illegible]	$2,[illegible]4,000

[1] Includes establishments engaged primarily in the manufacture of products not connected with the electric industries, but incidentally making electrical machinery, apparatus and supplies, as follows:

Year.	Number of establishments	Value of products reported
1909	[illegible]	$22,[illegible]
1904	128	18,742,[illegible]
1899	[illegible]	13,[illegible]

[2] Not separately reported

DEMONSTRATIONS OF THE UNITED STATES BUREAU OF MINES.

At the Arsenal Grounds, 40th and Butler streets, beginning at 9:00 a. m., October 30, 1911, and closing at 12 m. a demonstration of the work of the Bureau of Mines, with exhibit of detonation of permissible and other explosives, in the steel lined gallery, filled with dust and gas.

Exhibits and tests of mine safety lamps in lamp gallery; of electric sparks in gallery No. 2 in the presence of inflammable mixture of air and gas; of training in rescue work with oxygen helmets; of investigations and tests of explosives.

PRIMER OF APPLIED THERMODYNAMICS.[1]
THIRD LECTURE.

Fuels and Their Calorific Value.

In the study of Thermodynamics, should we adhere strictly to our subject, we should deal largely in the abstract in our consideration of heat forces. We shall find, however, that if we can keep before our mental vision a concrete idea of heat and some of the factors used in producing heat, it will materially aid us in getting a thorough grasp of the applications of Thermodynamics.

In engineering practice the process used to manufacture or supply heat is known as combustion. In order to bring about combustion, certain substances called fuels are heated to a relatively high temperature, and then when air passes over and through the heated fuels the oxygen of the air chemically combines with certain ingredients of the fuels used and large quantities of heat are given out. These quantities of heat in turn are corralled, as far as possible, by the mechanical devices which go to make up the boiler and are used to heat water, evaporating the same into steam, which, in turn, is used to perform useful work in the industries.

Among the so-called solid fuels may be mentioned wood, peat, bituminous and anthracite coal, charcoal, coke, and oftentimes various waste products, such as sawdust, bagasse, straw, and spent tan. The liquid fuels comprise crude petroleum and various tarry residues, while the gaseous fuels are composed of natural gas, producer, blast-furnace, water, and illuminating gas. The essential constituents in all fuels are carbon and hydrogen; the accessory, oxygen, nitrogen, and ash; and the bad qualities, water, sulphur, and phosphorus.

In order to fix our ideas relative to the good and bad qualities to be sought after in fuels, we shall now devote considerable attention to the discussion of crude petroleum, which, above all others, due to its practically unlimited supply, is the most useful fuel on the Pacific Coast.

Attention was first drawn to the presence of petroleum in California by the discovery of numerous oil seepages, in Los Angeles, Ventura, Santa Barbara, and adjacent counties. The recorded production in 1875 was but 3000 barrels, while, in the year 1910, the total reached the enormous figure of 77,000,000,000 barrels. Fig. 9 shows graphically the growth of this great industry in California. The United States Geological Survey, in 1908, reported 8450 square miles of possible oil territory in the United States, giving California 850 square miles, or about one-tenth of the total area, but they give her credit for one-half of the probable minimum oil production of the United States, or one-third of the probable maximum production as follows:

	Minimum	Maximum
California oil fields	5,000,000,000	8,500,000,000
All other U. S. fields	5,000,000,000	16,000,000,000
Total	10,000,000,000	24,500,000,000

A. F. L. Bell, in a paper before the San Francisco section of the A. S. M. E., has estimated that, taking the present production of 75,000,000, barrels as

[1] A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

the maximum consumption, we have ahead 52½ years' supply in proven territory, and for proven and prospective territory, about 230 years' supply.

Crude petroleum consists principally of various combinations of hydrogen and carbon, together with comparatively small amounts of nitrogen, oxygen, and sulphur. Taking hydrogen and carbon as the

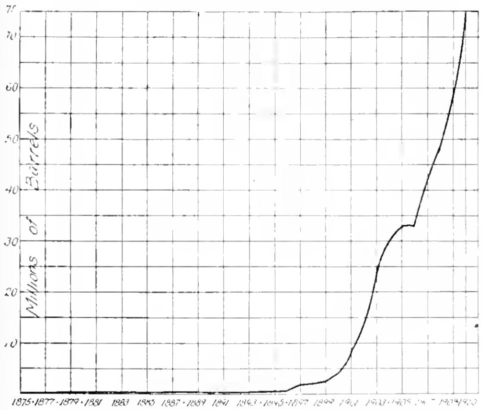

Fig. 9. Growth of California Oil Industry.

principal constituents, it is found that those oils which are rich in the former element are of light specific gravity as compared with those rich in carbon. The range in specific gravity of California oils may be taken as from unity to 0.84, or from 10 to 36 of the Baume scale. The majority of the fuel oils will range from unity to 0.9 or from 10 to 23 Baume.

Professor Joseph Le Conte of the University of California, by plotting a large number of calorific values of oils as shown in Fig. 10, derived an approximate relationship between heating value and specific gravity of oils, which can be found from the curve shown in the figure.

The Baume scale bears the following relationship with specific gravity:

$$\text{Sp. Gr.} = \frac{140}{130 + \text{B}} \quad \text{or} \quad \text{B} = \frac{140}{\text{Sp. gr.}} - 130$$

From the curve thus plotted Mr. Le Conte has deduced the following empiraceal law for heating value of California crude petroleum:

$$\text{B.t.u. per lb. of oil} = 17680 + 60\,\text{B}$$

where B is the reading on the Baume scale.

In order that petroleum may be burned with complete combustion, it is necessary that it be either gasified or injected in the form of spray into the furnace in which it is burned. Some forms of pan burners have been devised for use in hot air furnaces, where oil drips into the pan and burns from the surface, but they are of no importance in power or industrial work. A. M. Hunt, in a paper on the atomization of oil fuel read before the San Francisco Section of the A. S. M. E., has gone into this subject thoroughly, and his ideas are largely followed in the description of this process. In the first place, the general practice is to deliver the oil to the burner under pressure, and inject or pulverize it, using steam or air as the pulverizing medium. The oil so injected into the furnace should be entirely gasified or burned, while it is in suspension in the air; otherwise, if particles of unconsumed oil fall to the bottom of the furnace, coke will be formed, which gradually accumulates and builds up. Hence, if the furnace is short, the oil particles will have relatively short time period within which they must be consumed, and must, therefore, be smaller.

Hundreds of burners have been invented, and great claims have been made by each inventor as to the possible saving to be effected with his particular form. The burner, however, is really an item of minor importance in all oil burning installation, as compared with furnace construction, proper air admission, and other points.

Regarding the amount of steam necessary for atomization, various tests range from 0.2 to 0.6 lb. of steam per lb. of oil consumed. C. R. Weymouth, of Chas. C. Moore & Co., who has had wide experience in oil burning, states that 0.3 lb. per lb. of oil consumed is a reasonable figure to allow.

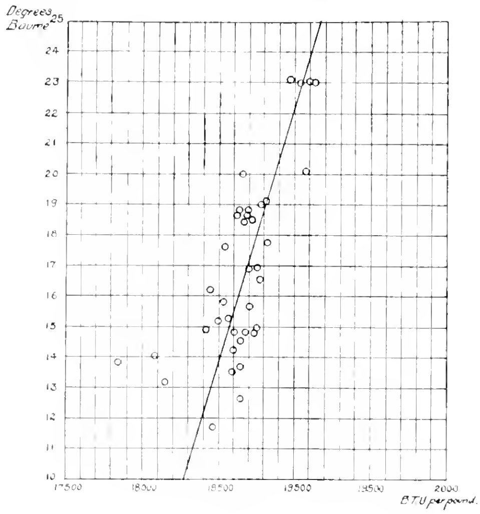

Fig. 10. Le Conte's Calorific Curve for Oils.

An excellent type of furnace used in oil burning is the so-called Peabody furnace. In this furnace the bridge wall is set back from the boiler front to give depth of from eight to ten feet, depending on the size of the boilers. The burner is of the back-shot type, inserted from the boiler front, under the floor of the furnace, turning up at the bridge wall. It shoots the flame forward toward the front of the boiler, so that this wall should have an extra course of fire-brick set in place without fire clay. At its front end, except in special boilers, the furnace should have a height of not less than six feet, and for large size boilers the height should be from seven to eight feet, depending on the character of the feed water and the desired overload.

Calorific Value of Fuels.

In our last lecture attention was called to the three methods used in engineering practice to deter-

mine the heating value of fuels, one of which methods was that arrived at by chemical analysis.

Before going into the subject matter at hand, it will first be necessary to get a clear conception of what in reality is taking place when we say a fuel "burns." In chemistry we learn that all matter composing our physical world is made up of about eigthy substances called "elements."

These elements under certain conditions group themselves into the thousands of substances known in our everyday experience. At times they are grouped together simply as a physical mixture, but at others by absorbing or giving out heat, they form new compounds entirely unrecognizable in any of the original elements. This change is to be distinguished from the change in physical state when a body absorbs heat in passing from the solid to liquid or liquid to gaseous state, and is called a chemical reaction. Thus, when one of these elemental substances known as carbon is heated and another elemental substance known as oxygen brought in contact, carbon dioxide is formed, and for every pound of carbon disappearing in the form of carbon dioxide an enormous amount of heat energy is given out amounting to 14,600 B.t.u. If, however, the air is stifled somewhat and a smaller quantity of oxygen consequently allowed to come in contact with the carbon, an entirely different compound known as carbon monoxide is formed, and only 4,450 B.t.u. per pound of coal is given out as heat. If we can coop up this gas, we can burn it again by bringing it again in contact with oxygen and produce the remaining amount of heat per pound of original carbon or 10,150 B.t.u. Hence in a furnace the all important point is to admit sufficient air to thoroughly consume the carbon in form of the former compound; otherwise the majority of heat is wasted. In making illuminating gas, on the other hand, the carbon monoxide is cooped up in gas mains and used for useful purposes in domestic life and in the industries.

In common fuels three elemental substances are found which uniting with oxygen of the air give out heat. In addition to the carbon just mentioned, hydrogen forms water with oxygen and liberates 62,000 B.t.u. per lb. of hydrogen so consumed. Sulphur similarly forms sulphur dioxide and liberates 4000 B.t.u. per lb. of sulphur. As sulphur forms but a small percentage in common fuels and as it has a tendency to corrode the tubes of boilers, its presence is usually considered a detriment rather than a benefit.

In the study of combustion, we find certain inert gases and compounds which it is necessary to consider. For instance, the air is composed of 1 part by weight of oxygen and 4 parts of nitrogen, another elemental substance. This nitrogen performs no useful purpose, but, on the other hand, must be heated to the temperature of the flue or chimney gases, and, as a consequence, is an actual detriment by its presence. In the same manner there is an enormous loss of heat due to moisture in the fuels. The water formed by the hydrogen and oxygen which must be evaporated and then superheated to the temperature of the escaping chimney gases.

Having determined by many careful tests the heat value of individual units of carbon, hydrogen, and sulphur, as stated above, Dulong, years ago, gave forth a formula by which the calorific value of fuel can easily be computed. As the oxygen in the fuel is undoubtedly united with its combining weight of hydrogen, it is first necessary to obtain the net amount of hydrogen available for combustion with the oxygen to be admitted to the furnace from without. Since 1 unit weight of hydrogen combines with 8 units of oxygen, the net amount of hydrogen useful for combustion is computed by subtracting from the quantity of hydrogen shown by analysis, an amount of hydrogen equal to $\frac{1}{8}$ the amount of the oxygen in the analysis. Hence the net amount of hydrogen available is $H - \frac{O}{8}$. With a few modern modifications, the American Society of Mechanical Engineers has adopted Dulong's formula for boiler tests. Since one pound of pure carbon will, when fully combined with oxygen, to form carbon dioxide, emit 14,600 B.t.u., and one pound of hydrogen will, when fully combined with oxygen to form water, emit 62,000 B.t.u., and one pound of sulphur will, when fully combined with oxygen to form sulphur dioxide, emit 4000 B.t.u., the truth of the formula is apparent, and is as follows:

$$\text{Heating value of fuel per lb.} = 14{,}600\ C + 62{,}000\left(H - \frac{O}{8}\right) + 4{,}000\ S$$

where C, H, O, and S are the proportions by weight of carbon, hydrogen, oxygen, and sulphur found to be in the fuel by chemical analysis.

Now it is evident that in a boiler all of this heat per pound of coal or fuel cannot be put to a useful purpose, because the nitrogen of the air which has been admitted to the furnace has not been consumed. In fact energy must actually be wasted upon it, for it must be heated to the temperature of the escaping gases. The water or moisture in the fuel, as well as the water formed by the oxygen in the fuel, must be evaporated and the steam superheated to the temperature of the departing chimney gases. Many other wastes of heat occur, but these we can compute with a reasonable degree of accuracy by the formula

$$\text{B.t.u. lost} = (9\,H + W)\ [212.9 - t + 965.8 + 0.48\ (t_c - 212)] + 0.243\ (t_c - t)\ N. + .21\ (t_c - t)\ CO_2$$

in which H, W, N and CO_2 are the proportional content of hydrogen, water, nitrogen and carbon dioxide t_c the temperature of the chimney gases, and t the temperature of the air admitted to the furnace.

It will be interesting, and at the same time exceedingly instructive, if we apply the two above written formulas to both coal and oil fuels. Let us take as an example tests of coal and oil as given by C. E. Wieland before the San Francisco Section of the A. S. M. E. in December, 1910, and printed in the Journal of March 18, 1911.

PROXIMATE ANALYSIS.

	Pocahontas Coal Per cent	Kern Crude Oil 14.5 Gravity Per cent
Fixed Carbon	73.30	
Volatile matter	17.61	
Moisture	.49	.15
Ash	8.60	
	100.00	

ULTIMATE ANALYSIS.

Carbon	82.26	87.64
Hydrogen	3.88	10.48
Sulphur	.49	1.02
Oxygen	4.12	.08
Nitrogen	.64	.78
Ash	8.60	none
	100.00	100.00

Substituting in Dulong's formula, we have for the calorific value of the coal per lb.:

$$14,600 \times .8226 + 62,000\ (.0388 - \frac{.0412}{8}) + 4000 \times .0049 = 14,112.8$$

Calorimeter Test = 14,067.

Calorific value of the oil per lb.:

$$14,600 \times .8764 + 62,000\ (.1048 - \frac{.0008}{8}) + 4000 \times .0102 = 19,327.6$$

Other methods of computing the calorific value of fuels have been put forth by various engineers. All of them have more or less merit and for particular cases prove not only short-cuts but exceedingly accurate. Dulong's formula, in the main, nevertheless, is to be desired above all others.

Beginning with the next issue, due to considerable interest on the part of the readers of the Journal, the Thermotwisters will appear solved. Four weeks will be allowed to elapse, however, for each series of solved problems. In a word, the problems appearing solved in next week's issue, will be those issued in conjunction with the first lecture, and there will appear in each following issue, completely solved, the Thermotwisters published four weeks earlier.

THERMOTWISTERS.

1. California oil has a specific gravity of 0.92 and it is found to contain 5% moisture. Apply Le Conte's formula and compute the calorific value per pound of oil.

2. A sample of Pocahontas coal is found by chemical analysis to contain the following ingredients:

Carbon	84.87
Hydrogen	4.20
Oxygen	2.84
Nitrogen	0.85
Sulphur	0.59
Ash	5.89
Moisture	0.76
	100.00%

Compute by Dulong's formula the calorific value of the coal per pound of fuel.

SAN FRANCISCO MEETING AND JAPAN EXCURSION OF MINING ENGINEERS.

A cordial invitation is extended to all members of the American Institute of Electrical Engineers to participate in the 101st meeting of the American Institute of Mining Engineers, which will be held in San Francisco beginning Thursday, October 10, 1911. It is proposed to secure for the party making the trip West a special train de luxe, which will leave Chicago on Saturday, September 30, 1911, at 8 p.m. A day or two each will be spent at the Grand Canyon of the Colorado in Arizona, Los Angeles, Santa Barbara and Del Monte. The party will reach San Francisco on Tuesday morning, October 10. In addition to the usual sessions for the reading and discussion of technical papers, the local committee in San Francisco contemplates a number of excursions in and about the city, including the oil fields, gold dredges, Mt. Tamalpais, Lick Observatory, University of California and Stanford University.

A similar invitation is extended to Institute members to participate in a special excursion to Japan. Accommodations have been secured on the steamships Manchuria and Siberia. The party will leave San Francisco on October 17, arriving in Yokohama on November 3. It is planned to spend 18 days in Japan, leaving Yokohama on November 21, arriving in San Francisco on December 7, Chicago on December 11, 1911. The excursion in Japan will include trips to the Tokio, Nikko and Chuzenji district, Kiota, Nara, Osaka, Kobe, Ikuno, silver mine, Imperial Steel Works, etc.

The complete itinerary giving full details including rates may be obtained on application to Dr. Joseph Struthers, secretary American Institute of Mining Engineers, 29 West Thirty-ninth street, New York City. Members desiring to participate in either of these trips should communicate with Dr. Struthers at once.

ILLUMINATING ENGINEERING SOCIETY.

The fifth annual convention of the Illuminating Engineering Society will be held in Chicago, Sept. 25th to 28th inclusive. A most helpful and attractive series of papers is in course of preparation for this gathering and unusual interest is being shown for the coming event. The program is as follows:

Presidential Address, "The Relations of Physico-Physiological Research to Illuminating Engineering"...... ....Dr. A. E. Kennelly

Report of Committee on Nomenclature and Standards.... ....A. J. Humphries, Chairman

Report of Committee on Progress..Dr. Louis Bell, Chairman

The Manufacture of Glass from the Viewpoint of the Illuminating Engineer..................E. H. Bostock

Symposium on Illuminating Glassware....Bassett Jones, Jr., ...A. J. Marshall, L. W. Young, C. M. McCormick

An Analysis of the Requirements of Modern Reflector Design ....F. L. Godinez

Recent Small Gas Lighting Units...............F. H. Gilpin

The Production of Natural Gas from the Illuminating Engineer's Standpoint ....G. S. Barrows

Recent Developments in the Manufacture of Incandescent Lamps . . ..J. E. Randall

Flames Carrying Electric Current.............C. F. Lorenz

The New Quartz Tube Mercury Arc Lamp....Geo. C. Keech

The Law of Conservation as Applied to Illuminating Calculations ....Dr. A. S. McAllister

The Photometry of Lighting Units of High Intensity.... ....Geo. H. Stickney and S. L. E. Rose

Photometry at Low Intensities................Dr. Louis Bell

Evaluation of Lamp Life.....P. S. Millar and L. J. Lewinson

Distribution of Luminosity in Nature..........Dr. H. E. Ives

Light Distribution—Its Influence Upon Illuminating Efficiency and Visual Acuity ....A. J. Sweet

Resume of Legislative Enactments on Illumination...... ....E. L. Elliott

Selling Illumination ....F. B. Rae

(Title to be announced later) ....J. R. Cravath

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A TRANSPORTATION RECORD IN CULEBRA CUT.

On August 14, nine 35-car small dump trains, and twelve 27-car large dump trains were handled to Gatun; fifty-one 21-car Lidgerwood trains were handled to Chagres district dumps, making a total of 72 trains, 1,710 cars, and 57,357 cubic yards handled out of the north end of the Culebra Cut on that date, which is the largest number of trains ever handled in one day out of that end of the cut.

ATTRACTIVE ADVERTISING.

The Southern California Edison Company has been putting out some attractive advertising in Los Angeles of late. The accompanying cut illustrates a unique campaign now being waged by the company in its efforts to incraese power consumption even in as small units as the eight candle-power lamp. The sacred shrine of the poet has evidently been invaded and its inmate made to pen his lines to assist in this remarkably energetic campaign as set forth below:

THE PORCH-LIGHT.

By Lawrence Greenhill

The light-house marks the hidden rock,
Beneath the frothy foam;
The porch-light sheds its rays around,
And guards the peaceful home.
Within the circle of its light,
No sneak-thief dares invade,
Because his well illumined form,
A target bold is made.

His guilty conscience paints a fate,
That's ghastly, swift and grim—
He thinks some fellow in the house,
Will draw a bead on him.
And so he passes up the spoils,
And skulks away in dread,
Lest some one in that lighted house,
Shall pump him full of lead.
Thus prowlers shun the lighted house,
And never dare go nigh,
Where on the porch the lantern glows,
An ever watchful eye.

In encouraging the use of the electric sign for advertising, the great power companies of the West are not only promoting a very lucrative field of power consumption, thus benefiting from it in a selfish way, but at the same time the beneficial results to the advertiser are almost incalculable. It is interesting to note the progress in the art of electric sign advertising, and from time to time in the pages of the Journal will appear some illustrations of the artistic taste used in up-to-date advertising. The progress in the art from crude signs to those of real artistic design is indeed very striking, and it behooves the power plant manager alert for new business to study the effects produced upon the general public in proportion to the time and thought given to it.

Formerly, due to the novelty of electric lighting effects, any contrivance that gave forth light could be used for effective advertising. The general public have, however, been educated up to the aesthetic side of things electrical during recent years. Hence, real merit displayed in developing this side of night signs is proving that it has no mean excuse for existence, but, on the other hand, progress demands its use.

WATER-POWER DEVELOPMENT IN AUSTRIA-HUNGARY.

BY JOSEPH I. BRITTAIN.

At present there is considerable interest being manifested in the further development of water power in Austria-Hungary.

In Hungary and Croatia there are two large projects under consideration concerning the final development of waterpower. One of these projects was outlined by the firm of Albert Buss & Co., of Basel, Switzerland, and is now under consideration by the Hungarian Ministry of Agriculture. According to this project, it is contemplated to utilize the waterpower of the Danube on the Pressburg-Raab section.

The plan comprises the construction of a canal which will equally serve the interests of navigation and irrigation. In the cities of Pressburg, Wieselburg, and Raab are to be built three reservoir embankments, by which it will be possible to produce an electric energy exceeding 40,000 horsepower, which will be partly used for lighting those cities. Aside from this, the industrial establishments in the neighborhood can be supplied with electric power. The cost of these plants is estimated at $8,120,000.

A second project, for the accomplishment of which French capitalists are interested, concerns the final development of the existing waterpower in the town of Zengg in Croatia. After completing the building of all locks the power obtained will be 60,000 to 80,000 horsepower. This power is to be furnished to the city of Fiume and to the whole Croatian and Austrian seacoast in that neighborhood.

It is further proposed by the management of the Hungarian Government Railways that power be furnished them to obtain electric current for operating the railways from Fiume to Croatia by electricity. The cost of building and completing this plant is estimated at $14,210,000 to $16,240,000. This project has so far progressed that exhaustive negotiations are already being made with those parties who might likely use electric power.

AMERICAN RAILWAY STATISTICS.

Statistics published in the 1911 edition of the McGraw Electric Railway Manual, which has just been published, show the miles of track, cars operated and capitalization of electric railways of the country in 1910. Statistics are also included, giving the principal returns of the companies which make public the details of their financial results of operation.

According to the total returns for 1,279 companies, the aggregate number of miles of track operated in 1910 was 40,088. These companies operated 89,601 cars and had $2,380,011,921 capital stock outstanding, and $2,302,094,296 funded debt outstanding. The total capitalization outstanding was $4,682,106,217. In previous years, comparison of the returns made to this work of reference have been given within a few weeks after publication of the volume in the Electric Railway Journal, in connection with which the McGraw Electric Railway Manual is published. The returns this year, however, are published in the Manual together with a comparison with the returns compiled in previous years. The comparison shows a small increase in the operating companies, the number of which was 1,253 in 1909. The total miles of track reported in 1909 was 40,490, and the decrease that is shown is due to the differences in the classification of the figures for the two years. The elimination of duplications in the reports of underlying and controlling corporations, makes an apparent decrease in the miles of track as well as in the total number of cars operated. The aggregate number of cars operated in 1909 was 91,953, according to the returns compiled for that year. A similar reduction is shown in capital stock outstanding which amounted to $2,427,935,397 in 1909. The apparent decrease is due to the elimination, so far as could be determined, of intercorporate holdings of securities. The amount of funded debt outstanding, on the other hand, showed an increase in 1910 as compared with 1909 of $77,294,060. The net change in total capitalization outstanding in 1910 as compared with 1909, owing to the increase in funded debt, is a gain of $29,270,584: The returns published in the Electric Railway Journal in previous years have not included a compilation of authorized capital stock and funded debt, but the totals for these items have been compiled for this year. They show that the total authorized amount of stock of electric railway companies in the United States in 1910 was $3,135,443,005. The amount of authorized funded debt at the same time was $4,047,275,207, making a total authorized capitalization of $7,182,718,212. In the tables, returns are divided by the states, and by groups of states, following the practice of the corresponding compilation in previous years.

The actual number of companies for which the principal results of operation are reported, is much smaller than that for which the other returns are given. This is due in part to the fact that the total number of companies which report capitalization, track and cars embraces many underlying companies whose earnings and expenses are included in the returns of a larger operating company. The discrepancy is also due to the fact that some of the companies do not make public details of the result of their operation. The gross revenue for 620 companies as given, amounted in 1910 to $478,873,671. The gross earnings, as stated, include the returns of some companies which did not report their operating expenses and net revenue. The operating expenses of companies that furnished figures for this item aggregated $272,076,243. The net revenue as reported was $195,234,698.

A comparison may be made between the returns of this compilation and those indicated in the earnings of street and electric railway companies of 1907. The census report is made up without publicity of the returns of individual companies, so that it contains figures which are not available for publication under ordinary circumstances in connection with the names of the companies concerned. There are differences in the basis of compilation of the two reports which, however, do not destroy the interest of a rough comparison. Where the total number of companies reporting in the McGraw Electric Railway Manual showed gross earnings of $478,873,671, the census report as of 1907 showed $429,744,254. The amount of authorized capital stock increased, according to the returns, 25 per cent in the period of three years. The amount of outstanding capital stock increased in the same time 13.5 per cent. The increase in the outstanding funded debt in this period was 37.3 per cent. The increase from 1907 to 1910 in the miles of track of electric railways operated was 17.7 per cent.

JOINT USE OF ELECTRIC LINE TO BE TRIED IN NORTH.

Following the introduction recently in the City Council of an ordinance providing for the condemnation and purchase of the Seattle, Renton and Southern Electric Railroad by the city of Seattle, President Crawford of the road has submitted a proposition to the city for the joint use of the line by the city, ownership to remain in the company. The city has voted to issue bonds for the construction of a municipal street railway from Renton to Salmon Bay, and it is proposed to make the Renton and Southern a part of the city's line.

A complete recital of the history of this struggle between the city of Seattle and the Seattle, Renton and Southern Electric Railroad appeared in the issue of the Journal of August 12. The outcome is of peculiar interest to those engaged in electric transportation on mission to determine the value of cement mortar,

CEMENT AS AN IRON PRESERVATIVE.

Tests are to be made by the Panama Canal Com-
the Coast, as it marks the first of its kind in the West.
applied to iron plates by the "cement gun," as a preservative of iron. Twelve plates, 63-8 by 14 inches, have been coated with a 1 to 3 mortar of cement and sand, after they were cleaned to grey metal by the sand blast process. Six of these have been covered with a ½-inch coating, and the remaining six with a one-inch coat on one side, and a 1½-inch coat on the other. Three plates of each kind have been sent to Balboa, and three to Cristobal, where they will be kept immersed in salt water to test the mortar method of preventing corrosion. Two plates of each kind will be taken from the salt water bath at the end of three months, and one-half of the coating will be removed to determine the condition of the metal. The duration of the test for the balance of the plates will be determined later.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Pacific Coast Conventions

Philosophers tell us that man is a social being and cannot live by himself alone, but of necessity must depend largely upon his fellows for his material existence. Great physical barriers have had the utmost influence in the past in developing a tribe or nation. The Anglo-Saxon's stalwart qualities and independence of thought are doubtless due to the separation of the British Isles from the mainland by the English Channel. Thus was forced upon him self-dependence and a stronger community interest in all of his undertakings.

In our own country the great range of the Rocky Mountains forever stands as a barrier to separate the West from our older brothers in the East. The immensity of our great Western Empire has imbued those whose homes are in the West with ideas of comradeship and grasp of big undertakings in keeping with its traditions. Western frankness, openheartedness, hospitality, and optimistic, boosting spirit are felt and recognized the world over.

Those associated in a common industry in the West, separated as they are by thousands of miles from sister industries of the East, feel a peculiar inter-dependence of the one upon the other. Here are found problems to contend with hitherto unknown to human experience. A convention or getting together, then, of all those engaged in solving the peculiar problems, met with in the West, in any one industry, is of the greatest importance.

The Pacific Coast Gas Association, which convenes in annual convention in Oakland on Sept. 19, 20, 21, is now almost ready to graduate from its teens, this being its nineteenth annual gathering. The long list of helpful meetings held in the past assures its permanent success. The gas industry on the Coast is peculiarly distinct and unique. The annual gatherings with their list of helpful papers are largely responsible for the high state of efficiency maintained in this industry in the West. Aside from these helpful discussions, the very getting together does more to foster the true Western spirit than any other factor

The other two Pacific Coast gatherings of the week—the Northwest Light and Power Association, at Spokane, and the Pacific Coast Electrical Jobbers, at Portland—are likewise deeply imbedded in the hearts of western technical men and with intense interest these proceedings will be watched by their brothers who are unable to attend.

The West is just entering upon a period of unprecedented commercial activity. Some are prone to believe that in the hurley-burley of the commercial struggle ahead, much of the old comradeship and whole-souled fellowship peculiar to our Western life may be forgotten. The social side of these Western conventions which has been so prominent in the past, lends an important and deeply felt aid in keeping alive this spirit of fellowship. Let everyone interested see to it that it shall never die.

Electric Gas Meters

Elsewhere in these columns will be found a detailed description and accurate test of the Thomas electric gas meter. The subject is an interesting one, first because of the application of electrical energy in the measuring of gas and again it is interesting in that by supplying a small quantity of heat to a gas and measuring the temperature difference before and after the application, or, what is practically the same principle by maintaining a constant difference of temperature and measuring the varying supply of heat necessary, an accurate meter can be devised.

From elementary Thermodynamics we learn that the weight of a given gas multiplied by its specific heat and again multiplied by its rise in temperature will give the amount of heat supplied. Now it is evident that if we can supply a constant amount of heat to a gas and that if we can measure the difference in temperature before and after the application, the quantity of gas is at once inversely proportional to this difference in temperature. This was the first principle employed by Professor Thomas in his experiments. The inverse proportion is not readily open to continuous readings, however, so that he next by means of supplying an electric current in varying amounts was able to maintain a constant difference of temperature. Consequently the amount of current supplied under these conditions is definitely proportional to the quantity of gas passing between the two points where the difference of temperature is maintained constant. Since this is true, the reading of an ordinary wattmeter will, when once calibrated, read thereafter accurate measurements of gas quantities. From the series of tests put through upon the meter as detailed in the article referred to, the comparison of this meter with standard quantitative measuring devices is very flattering to its designers.

Trend of the Electrical Industry

As the awe-inspired sight-seer, for the first time climbing the rocky-lining of the great Pacific, observes the in-coming tide, thoughts present themselves which come at no other period in life's experience. A whirl-pool here casting into oblivion small pieces of float, struggling to keep above water, an eddy there taking out to sea what has recently been carried into shore, the continual swelling and heightening of the waters and their dashing against the rocks, and, above all, the loud-roaring din and turmoil of the whole, bring before his imagination more forcefully than can ever be pictured in words the struggle and onward progress of a great industry.

Elsewhere in these columns will be found a summary of statistics just compiled by the Census Bureau on Electrical Machinery and Apparatus. A careful reading of these statistics will unfold many interesting facts to the discerning eye of the student, and in these figures will be seen largely pictured, the results of the struggle and onward progress of the great electrical industry during the past decade. In them we can see how certain classes of design have struggled for an existence, but in the whirl-pool of competition with improved and more efficient apparatus have been forever cast into oblivion; other forms are being carried in the eddy out to sea, while still others, strengthened by experience gained and by the constructive imagination of their inventors, are coming into favor with the incoming tide, sweeping everything before them.

One of the most striking features is the steady increase in capacity of generating units and the steady decrease in capacity of operating units. Thus, it is shown that while much larger and more powerful generating units were manufactured in 1909 than for the prior years, although the average value of machines manufactured was greater, the machines represented a lower cost for corresponding capacity. The steady trend toward increase in generating units is shown by the fact that the average capacity was 55 kw. in 1899, 66 kw. in 1904, and increased to 84 kw. in 1909. On the other hand, indicative of the enormous swelling in power consumption we find that motor units employed increased 586 per cent, representing an increase in value of 142 per cent. The trend of the size of units employed in the motor shows itself in contrast to that of the generator, in that the individual units are growing proportionately smaller, being 14.5 h.p. in 1899, 8.5 h.p. in 1904, and 6.7 h.p. in 1909. Unquestionably the great centralization of hydroelectric units in the far-off mountains and the auxiliary steam plants in the big distribution centers have had their effect by increasing the average capacity of generators, and with this have also come the varied uses of electrical motors in the industries. The past ten years have substantially proved the efficiency of individual motors in factory operation, thus reducing the capacity per motor, though enormously increasing the total number in use.

In the hitherto unheard of increase of 223 per cent in ten years for transformers, and for dynamotors, motor generators, rotary conveters and the like, an increase of 720 per cent, the use of long distance transmission of electrical energy with the consequent popularity of alternating current indelibly shows itself.

A glance at the summary headed Arc and Incandescent Lamps is interesting and instructive. In a word the arc lamp industry shows itself practically at a standstill, while its younger but more energetic brother, the incandescent lamp, shows a total increase for ten years of nearly 350 per cent, having increased from a total of $3,515,000 in 1899 to the enormous total of $15,715,000 in 1909.

The electrical industry, as a whole, shows an increase of from $105,832,000 in 1899 to $159,551,000 in 1904, and $243,967,000 in 1909, or the rate of increase from 1899 to 1904 was 51 per cent, while from 1904 to 1909 it was 130 per cent.

Shades of Benjamin Franklin!!

If such accelerated increases continue during the next few decades, the child of our creation will become so enormous in his proportions, we may defy any one to foretell the far-reaching hold the great electrical industry will have upon the future of mankind, and the inexpressible service it will render in the elevation of the human race by bearing its now crushing burdens.

PERSONALS.

S. K. Colby, of Pierson, Roeding & Co., left last Tuesday on a business trip to New York.

F. W. Gay, a mechanical engineer, with J. G. White & Co., left for New York during the past week.

H. R. Noack, manager of Pierson, Roeding & Co., has returned to his San Francisco office from Southern California.

Clarence Follis, formerly of the Brooks-Follis Company, and now a New York broker, is visiting relatives at San Francisco.

M. E. Launbranch, of the United States Electric Company, of Chicago and New York ,is a recent San Francisco visitor.

W. B. Matheson, of Phoenix, Ariz., has succeeded Frank T. Alkire as secretary of the Overland Telephone & Telegraph Company.

E. S. Harris, who is connected with the Westinghouse Lamp Company, has arrived at San Francisco from East Pittsburg.

A. E. Wishon, manager of the Bakersfield district of the San Joaquin Light & Power Corporation, visited San Francisco during the past week.

Frank A. Cressey, Jr., who is connected with the management of the Modesto Gas & Electric Company, has arrived at San Francisco from Modesto.

H. A. Lardner, manager of J. G. White & Co.'s Pacific Coast branch, left last Monday for the New York office, and will spend three weeks in the East.

H. B. Rutledge has purchased the controlling interest in the Glencoe Electric Light Company, and consequently has permanently located at Glencoe, Minn.

C. E. Groesbeck, one of the vice-presidents of H. M. Byllesby & Co., of Chicago, returned during the past week to his headquarters at Portland, after visiting San Francisco.

Fred L. Webster, Pacific Coast manager for the Allis-Chalmers Company, has just returned to his headquarters at San Francisco, after visiting the company's Los Angeles office.

S. L. Nicholson, sales manager of the Westinghouse Electric & Manufacturing Company, has been paying a visit to W. W. Briggs, assistant sales manager of that corporation at San Francisco.

Robert Mather, chairman of the board of directors of the Westinghouse Electric & Manufacturing Company, spent a few days of last week at San Francisco, after looking over his mining properties in Trinity County.

H. H. Noble, president of the Northern California Power Company, returned to San Francisco last Tuesday after visiting the new Coleman power station, which is to be placed in commission about the last of September.

W. D. Ward, of the Pelton Water Wheel Company, has just returned from a tour of Utah and Colorado, after securing for his company a contract for a 1000 h.p. water wheel for use in the new municipal electric light and power plant at Longmont, Colo.

A. H. Halloran, managing editor of the Journal of Electricity, Power & Gas, has left on a tour of the Northwest, in the course of which he will attend the Northwest Light & Power Association convention at Spokane, and the Pacific Electrical Jobbers' convention at Portland.

R. A. Thompson, formerly chief engineer of the Wichita Falls & Northwestern Railroad in Texas, has been appointed chief engineer of the California Public Service Commission. Mr. Thompson comes thoroughly equipped to handle his new duties, having served on similar commissions in two other states.

ELECTRICAL CONTRACTORS' NOTES.

Carl Heilbron, first vice-president, was in Los Angeles last week.

Louis Levy, the manager of the Day Electric Company, spent the past week at Healdsburg with his family.

C. V. Schneider, of the Electric Supply Company, of Sacramento, has just returned from a two weeks' hunting trip in the northern part of the state.

D. T. Gallivan, superintendent for the Newberry-Benheim Electric Company, and Al. Drendall have just returned from a hunting trip in Mendocino County.

John Rendler, president of the California State Association of Electrical Contractors, made a visit to San Diego. President Rendler reports work steady and everyone doing nicely.

Secretary W. S. Hanbridge writes as follows: "A great deal might be said on both sides in reference to the cooperation of lighting companies and contractors, but the following clipping from Emersons Monthly says so much in so few words that it should be readily digested:

" 'The writer happened into one of our warm cities about July 4 this year. There were three contractors in town in addition to the lighting company. The lighting company was selling fans at cost. One contracting firm was heavily stocked with fans that he could not sell. The other two were busy knocking fans. Can you imagine any one knocking a fan with the heat above 100 degrees in the shade?'

It is futile to hope to increase the sales of fans materially by improper merchandising methods, such as selling at cost, and central stations following that policy are certain to regret it at some later time.

Meanwhile, if some lighting companies insist on following the plan of selling fans without a proper retail profit, the dealers affected can only devote their attention to some more profitable business, and wait for the "light of reason" to break in on the lighting company. Such central stations must sooner or later come to a realization that the active co-operation of all the electrical interests in the community is of considerably more value and will actually result in selling more fans than any policy which eliminates such co-operation."

TRADE NOTE.

The United States Reclamation Service has recently ordered from the Westinghouse Electric & Manufacturing Company, for installation on the Boise project, Idaho, three 625-kva., 22,000-volt, three-phase, air-blast type transformers. The government has installed on this project a hydro-electric power plant for furnishing energy to moter-driven pumps used for irrigating purposes. As the irrigation season occupies only the summer months, the plant will be kept in part operation during the winter for the purpose of supplying light to the farmers and the small towns on the project.

NEW CATALOGS.

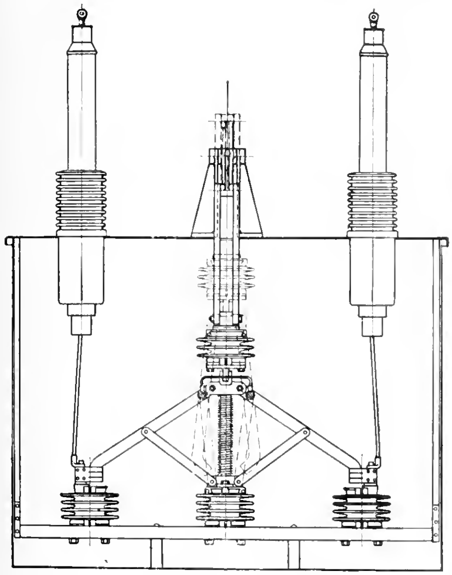
The General Electric Company has just issued a new series of Bulletins. No.4878 is devoted to Cloth Pinions. This remarkable and somewhat radical form of machine element is offered for a wide variety of application in mechanical transmission of power where, because of noise or for other reasons, the meshing of metallic pinions, with metallic gears is impracticable or undesirable. Bulletin No. 4869, is an attractive publication devoted to motor drive for the printing and allied trades. The advantages to be derived from motor drive in this industry are the improved plant location made possible by the use of central station power, reliability, speed variation and control, economy of space, increased production, economy of power, and, what is exceedingly important in the printing trade, cleanliness.

INDUSTRIAL

KELMAN OIL SWITCHES AND CIRCUIT BREAKERS.

Apace with the rapid advance in high tension transmission, has been the desire on the part of the manufacturer, tending toward the perfection of the protective apparatus. Especially is this so with high tension oil switches and circuit breakers, as probably no other single piece of apparatus is called upon to act so quickly, effectively and under such severe conditions at times.

The accompanying cut will illustrate a new feature of the Kelman circuit breaker. The operation of this breaker has been described before in these columns, and is based on the well known pantograph mechanism, but employing an improved method of guiding the contacts, and giving them the desired movement. This consists of placing a telescoping guide



Improved Kelman Oil Switch.

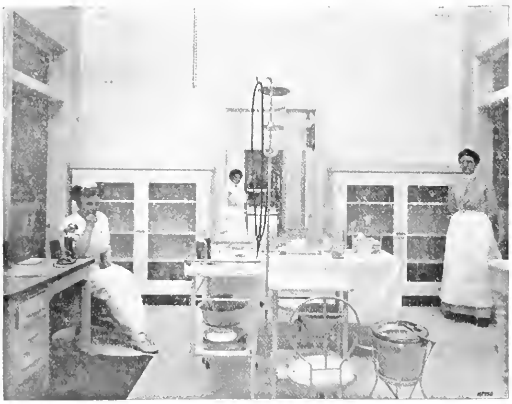
(a) within the pantograph, the outer member being attached to the central insulator (b), and the inner member to the yoke (c). The coiled spring (d) is placed on the guide which is compressed when the switch is closed and is of sufficient strength to open it and hold it in the open position. By this method the contacts are always maintained in correct, but not in rigid alignment, a slight amount of flexibility being allowed, which prevents any undue strain on the porcelain insulator. The compression spring on each guide permits the use of a contact mechanism, which is light in weight, and has very little inertia, such as there is, being absorbed by the springs, thus preventing a shock to the mechanism, even if closed violently. This is an important point, especially in the case of solenoid operated switches, where the voltage of the control circuit varies widely. Another feature of this breaker as will be seen by the cut, is the depth of the terminals in the oil, insuring a larger body of oil over the contacts and consequently greater static pressure to dissipate the arc. One of the most frequent sources of trouble in oil switch operation has been the tendency of the explosive effect to blow the oil out of the tank, when the breaker opens. This type of circuit breaker eliminates entirely, troubles of this kind, by reason of the greater static head of the oil, as the efficiency of the oil varies with the depth of the break.

The horizontal break which has always been a feature of this breaker is also a powerful factor in aiding the rupturing of the arc, as the weight of the oil begins to be effective immediately upon the first movement of the contacts. The placing of these contacts has made it possible to use about one-half the quantity of oil per pole, as would be necessary if the break occurred higher in the oil. These breakers are manufactured for any voltage up to 110,000 both in hand, air and oil.

THE WESTERN ELECTRIC COMPANY'S NEW HOSPITAL AT HAWTHORNE.

Approximately 13,000 employes of the Western Electric Company are situated at Hawthorne, just outside of Chicago. The company's property at this point occupies more than 150 acres, and here are gradually being concentrated all of its manufacturing activities.

With the realization that it is necessary to look after the welfare of so many workers, the company has recently



Operating Room, Western Electric Co.'s Hospital.

built and equipped an emergency hospital on the grounds. Its object is not only to relieve distress in time of accident, but also to give aid to any who are taken sick while on duty.

Every detail is complete to furnish surgical aid in cases requiring it, this aid ranging from the major surgical class to fine and delicate operations on the eyes. The hospital does not take care of chronic cases, but merely gives aid in acute cases.

This is not a general hospital, but has been organized for emergency work only. Its construction and the arrangement of its rooms have been to carry out the thought of emergency work and to care for accidents that arise. Its services is furnished free of expense to employes.

TRADE NOTE.

The Olympic Power Company of Fort Angeles, Wash., has recently placed with the Westinghouse Electric & Mfg. Company an order including two 3000 kva. waterwheel generators, seven 1000 kva. water-cooled transformers of 38200 volts, on the high tension, with the usual exciters and an expensive switchboard.

NEWS NOTES

FINANCIAL.

PUYALLUP, WASH.—Seventy-five thousand dollars worth of water bonds will be placed on the market by the city within a few months, and the entire system of water supply will be reorganized.

ORANGE, CAL.—At a meeting of the City Trustees a call was issued for an election to be held October 2 to vote on the question of issuing $50,000 bonds for the water department, and $5000 for fire department.

SAN FRANCISCO, CAL. Suit has been filed in the United States District Court by the Los Angeles Trust & Savings Bank, trustee in bankruptcy of the estate of the San Bernardino Valley Gas Company, asking that the Merchants National Bank, of this city, be required to deliver to the trustees forty first-mortgage refunding bonds of the bankrupt company of a par value of $1000 each, given as security for a note for $15,000, which was renewed from time to time before and after the bankruptcy proceedings. By means of the transactions with the notes and the bonds it is claimed that the Merchants National Bank was enabled to get a greater percentage of the gas company's bonds than other creditors. It further is stated that out of an authorized bond issue of $1,500,000, to the amount of $184,000 were sold and $648,000 held as collateral for loans, $400,000 of which were so placed that they might be sold by the lenders. An order was issued by Judge de Haven directing the Merchants National Bank to show cause September 11 why it should not be permanently restrained from disposing of the bonds.

ILLUMINATION.

KALISPELL, MONT.—Property owners of this place are petitioning the creation of a lighting district for the installation of an up-to-date lighting system.

EUGENE, ORE.—J. H. Causey & Co., of Denver, has been awarded the contract for a $57,000 light, power and water bond issue. The firm offered a premium of $230.

LOON LAKE, WASH.—Gerhke & Sons, proprietors of the local planing mill, have received offers from outside capital to finance an electric light plant, to be operated in connection with the mill.

PEARL HARBOR, H. T.—The contract for furnishing boilers for an auxiliary power plant equipment at the naval station at this place has been awarded to C. C. Moore & Co., of 99 First street, San Francisco, at $158,000.

NAMPA, IDAHO.—J. A. Jones has been granted permission to construct and maintain a gas plant in Nampa and to use the streets and alleys for laying pipe lines on condition of repairing the same, for a period of 25 years.

CENTRALIA, WASH.—The Tenino Light & Power Company, recently taken over by the Washington-Oregon Corporation, has applied for a franchise to construct a pole line through this city, and extending from the City of Tenino to Chehalis.

GREAT FALLS, MONT.—The Great Falls Gas Company states that work has practically started on an addition to its plant. The new addition, which will cost $40,000, will double the capacity of the plant, and A. E. Potter, general manager of the company, is here to supervise construction work.

BAKERSFIELD, CAL.—Rio Bravo will soon have natural gas pipes in to operate the many pumping plants recently installed there. The gas company plans a system to cost approximately $25,000. Among those who were present at the meeting were Messrs. Hegg, Knight, McClellan, Van Dunn and Updike.

VALLEJO, CAL. The Pacific Gas & Electric Company applied for permission from the City Council to tear up Santa Clara street, between Virginia and Capitol streets. The company wants to put down a six-inch main for gas.

PALMS, CAL.—A committee, with S. A. Sterns as chairman, composed of one resident of each street in Palms, has agreed to install seventy-five electric lights in the streets of this vicinity beginning October 15. The plan is approved by the contributors in the assessment district.

PRINCE ALBERT, SASK.—The ratepayers of this place have endorsed by-laws to raise the sum of $775,000 for the development of 3500 h. p. at Lacolle Falls, on the Saskatchewan River. Cecil F. Smith, the engineer, will have charge of construction work on the project when started.

INCORPORATIONS.

SAN FRANCISCO, CAL.—The West Sacramento Electric Company has been incorporated for $100,000 by B. P. Lilienthal, H. W. Furlong, W. Herlitz, T. T. C. Gregory and C. J. Goodell

ESCALON, CAL.—The Escalon Water & Light Company has been incorporated for $10,000 by J. W. Smith, S. T. Irwin, H. T. Brennan, J. N. Leighton, H. J. Alley and H. L. McPherson.

FULLERTON, CAL.—The El Modent Mutual Water Company has been incorporated, with capital stock of $43,000. The directors are: F. E. Crawford, E. V. Crawford and G. B. Lancaster.

SAN FRANCISCO, CAL.—The Placer Electric Power Company has been incorporated for $2,000,000, by R. H. Borland, F. W. Nightingill, R. T. Harding, N. C. Butler and I. Lindemann.

SAN DIEGO, CAL.—The San Diego, El Cajon & Escondido Railway Company has been incorporated, with capital stock of $2,250,000, of which $60,000 has been subscribed. The incorporators and directors are: William Stell and C. O. Nichols, of El Cajon; W. L. Ramey and Frank C. O'Kelly, of Escondido, and G. W. Purcell, H. G. Crowe and C. C. Riordon, of San Diego.

TRANSMISSION.

TENINO, WASH.—The Tenino Light, Power & Water Company has filed acceptances and bond for franchises granted recently by the Municipal Council of this city.

LOS ANGELES, CAL.—The F. O. Engstrom Company has been awarded the contract, at about $10,000, for the erection of a re-inforced concrete substation at Colton for the Southern California Edison Company.

VALE, ORE.—L .L .Nunn and others, of Salt Lake City, connected with the Telluride Power Company, were in this city recently, looking over local conditions preparatory to making arrangements for the erection of a power plant.

SPOKANE, WASH.—The engineering work is now in progress on the plan of the electrical power development of the Kootenai River at Kootenai Falls, Mont., to cost $6,000,000, which is destined to furnish the northwestern portion of the Inland Empire with electrical power. The promoter of the enterprise is J. A. Coram of Boston, Mass. The plant is to be located 7 miles east of Troy and 11 miles west of Libby, Mont.

TWIN BRIDGES, MONT.—The survey of the Madison River Power Company's power line from Ruby to this city has been completed. The line will follow the Northern Pacific track from Laurin and will be built outside of the right-of-way fence.

PRINCE RUPERT, B. C.—Special election has been voted to he held in September on a by-law providing for the construction of a municipal hydro-electric system, creating a bond indebtedness of $550,000. It is proposed to transport water from Lake Woodworth and establish two systems, one for power and the other for water.

SAN JOSE, CAL.—That the Great Western Power Company intends coming into San Jose, and will probably erect a steam plant in this city without delay to furnish electric power and lights until the long distance transmission line is constructed was the significant statement made by Leo D. Haas. Mr. Haas figures that his company will expend close on to $250,000 in this city.

VANCOUVER, B. C.—C. C. Moore, Henry building, Seattle, has received a contract, at about $250,000, for the installation of four Babcock & Wilcox boilers, 500 h. p. each, and capable of operating a 2000 k. w. Allis-Chalmers turbine generator. A 260-foot reinforced concrete stack will also be built, and the system will be installed in the power plant of the British Columbia Electric Railway Company.

FRESNO, CAL.—The first carload of material for the Los Banos power line to be built by the San Joaquin Light & Power Company, are being sent out from Fresno. The work of transporting the wires, cables, poles and transformers will require some time. A few cars will be sent out daily. Work on this line, which will tap a rich alfalfa country, is to begin at once. The extension is to be made from the Madera county power line, and will be 80 miles long. It is to be completed by the middle of November. Dos Palos, Los Banos, Gustine and three or four other towns will be supplied with power.

RIVERSIDE, CAL.—Manifold & Poole of Los Angeles are the engineers for the new power system to be established in San Barnardino, Riverside and other Southern California towns by the Southern Sierra Power Company. The contract for the steel posts for the transmission line to be constructed from plants in Inyo county to Riverside has been awarded to Milliken Bros. of New York. The contract for installing all machinery and drawing the plans for the buildings for the steam plant which will be erected at San Bernardino has been awarded to C. C. Moore & Co., of Los Angeles. This plant will cost $200,000 and will be used until the power from the water power plants becomes available.

CORONA, CAL.—Since the filing of articles of incorporation of the Southern Sierras Power Company and Sierra Construction Company in Riverside, developments have been following rather thick and fast. These companies, whose stockholders are prominent Denver capitalists, have been represented in this section by F. A. Worthey of Riverside. The contract for a steam plant to cost in the neighborhood of $300,000 has already been let. This is to be located in the vicinity of San Bernardino, the exact location not having yet been made public. The new company has let contracts for transmission and distributing lines to tap this section as well as the Moreno and Perris Valley and West Riverside sections. It seems probable also that extensions will be made to Elsinore.

TRANSPORTATION.

SALEM, ORE.—It is reported that the Oregon Electric Company will begin construction work at once on the extension from this place to Albany.

WATTS, CAL.—The City Council has passed an ordinance granting to the Pacific Electric Railway Company the right to construct and for a period of fifty years to maintain and operate an electric railway upon certain streets of this city.

PACIFIC GROVE, CAL.—The Monterey & Pacific Grove Street Railway Company are planning to extend their line from Nineteenth street in this city by the way of Lighthouse avenue and Willow street and Spruce avenue to the Presidio of Monterey.

RIVERSIDE, CAL.—The City Council will receive sealed bids up to Sept. 26 for the purchase of a franchise granting the right to construct and for a period of forty-five years to maintain and operate a double track electric railroad on certain public streets of this city.

SALEM, ORE.—At a special meeting of the local municipal council the ordinance granting a franchise to the Portland, Eugene & Eastern Railway to operate a street railway here, was repealed. The company, which has franchises in Eugene, Albany and other towns, is charged with failure to comply with the terms of its franchise.

CARSON CITY, NEV.—D. W. Williams is in Oakland on a trip connected with a scheme which, if it bears fruit, will be of the greatest benefit to Carson City. Mr. Williams is endeavoring to raise capital enough to put in an electric line between this city and Glenbrook. Half a million dollars, it is estimated will build and equip the road and within three years' time Mr. Williams believes that it will be a paying investment.

SALEM, ORE.—The Oregon Electric Road, a Hill line, will continue the present line which terminus is Salem and will run a road to Albany. A right of way has been secured, with the exception of a few property owners who are holding out. The company has sent out four crews of surveyors to work the line. Bids for the construction of the road have been received from three companies, but on account of the right-of-way controversy the bids were not opened.

SAN FRANCISCO, CAL.—Work has been begun on the Sacramento and Woodland electric road, a part of the Northern Electric system. The line will be inoperation by May, 1912. It will traverse the West Sacramento property, the Bright lands and following the river, will reach Elkhorn, thence to Woodland, a total distance of 19½ miles. It will pass over the tules on a 15-foot grade, the roadbed also serving as a levee. The line will give Woodland access to the Western Pacific at Sacramento and to the Santa Fe at Stockton over the Central California Traction rails.

WENATCHEE, WASH.—The Wenatchee Traction Company has received a franchise along Wenatchee avenue for the construction of a street railway system and as a portion of an interurban line that will eventually extend along the Columbia River Valley from the town of Cashmere to Beverly, connecting at the latter point with the Chicago, Milwaukee & Puget Sound Railway. The company states that 100 miles of electric road are contemplated. The officers of the company are: L. W. Pratt, president; Henry Hewitt, vice-president, and Walter M. Harvey, secretary and counsel, all of Tacoma.

TELEPHONE AND TELEGRAPH.

ELGIN, ORE.—Citizens of Union and Wallowa Counties have organized a company and will construct a phone line between the two places.

PLUMMER, IDAHO.—The Plummer Home Telephone Company has completed organization. The officers are F. H. McCaslin, president; R. Malvon, vice-president; R. L. Stout, secretary; H. Mercer, treasurer, and R. A. Malcern, general manager.

APLHABETICAL INDEX TO ADVERTISERS

KELLOGG SWITCHBOARD & SUPPLY CO.

GENERAL OFFICE AND FACTORY
CONGRESS AND GREEN STREETS
CHICAGO

PACIFIC COAST SALES DEPARTMENT

CABLE ADDRESS
SWITCHBOARD
SAN FRANCISCO
LIEBER'S CODE

SAN FRANCISCO CAL. Sept. 11, 1911.

T. B. Strong, President
Technical Publishing Co.,
604 Mission St.,
San Francisco, Cal.

Dear Sir:-

It will probably be of interest to you to know something about the results from our advertising in the Journal. A short time ago we received an inquiry, which to date is the long distance record. Among other inquiries in answer to one of our ads covering mine telephones and other special equipment for mines is one from a concern in Constantinople. This concern not only inquires for prices on this equipment, but also is figuring on handling our entire line throughout Turkey.

Yours very truly,

KELLOGG SWITCHBOARD & SUPPLY CO.

Per H. Woldrick
Pacific Coast Sales Mgr.

HOG
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JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

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ELECTRICAL FEATURES PANAMA-PACIFIC INTERNATIONAL EXPOSITION

BY HAMILTON WRIGHT

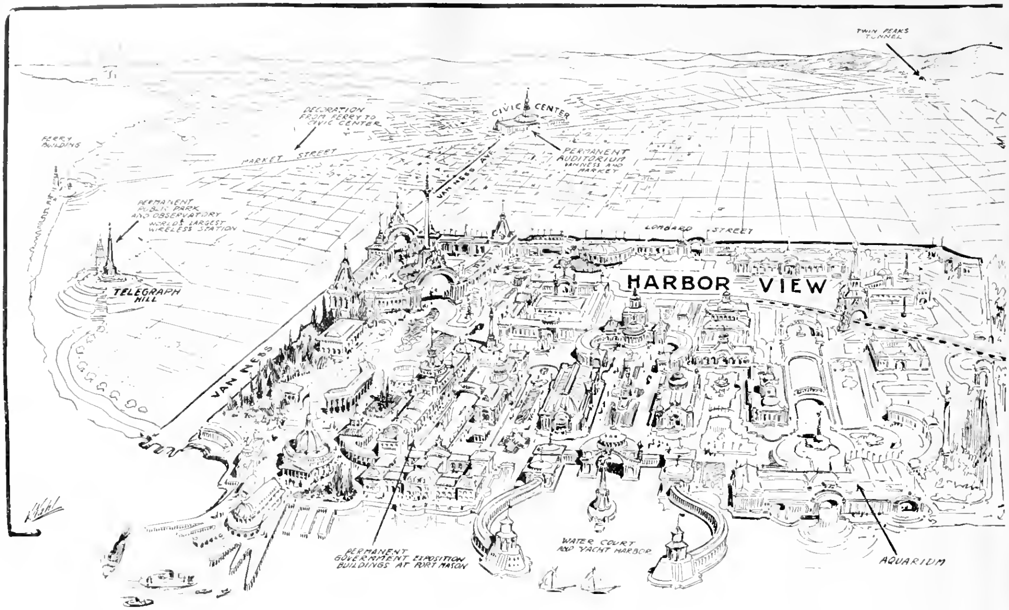
While all plans for exhibits at the Panama-Pacific International Exposition in 1915 are in a process of evolution at the present time, and any outline of what may be accomplished must, therefore, be somewhat speculative in its nature, yet the absence of any ordinary limitations upon the huge total of electrical power available for the Exposition, the character of the displays planned and the extraordinary progress of recent years in the application of electricity to the most varied commercial uses, all promise that visitors will have set before them the greatest diversity of electrical features ever exhibited in a single locality.

There is every reason why a World's Exposition held in California should have from the very beginning a great advantage for the display of electrical features. In the development and perfection of extremely long distance high tension transmission lines California is, historically, first. The world's first experiment [illegible] transmission was made in Germany in 18[illegible] [illegible] a line of 108 miles was run into [illegible] to light an exposition held there that year. [illegible] the first electrical power plant in the [illegible] States in which, as a prime mover, water was used, was begun at Pomona, Cal. This

CHAS. C. MOORE, President

H. D. H. CONN[illegible], D[illegible] WORKS

Upon These Two Public Spirited Citizens [illegible] of the Greatest Expositi[illegible]



Courtesy of San Francisco Examiner

Pictorial View of Panama-Pacific

was followed by the big plant at Folsom, Cal., which, at that time, was the largest in the world. The first current that flashed along its wires carried 400 horse power 21 miles at a voltage of 11,000. The work on the Folsom plant was only second to that at Niagara Falls and the great plant furnished 45,000 horse power, transmitted a distance of 24 miles to Sacramento for use by street car lines, electric lighting companies and in factories and machine shops.

The success of the Folsom plant was only made possible by the fact that the year after it started a dynamo was invented which made electric power available for manufacturing purposes. The first plants could employ their currents for lighting and for the propulsion of street cars alone, but here was a new application which made the patronage and profits of the concerns doubly sure. Electric power was eagerly caught up all along the transmission lines and today in California it is used for the greatest variety of purposes. At the Exposition California alone could show as wide a diversity of the application of electrical power to commercial uses as perhaps any other region. Only a fraction of the possible power has been developed. The Great Western Power Company's new plant affords one an opportunity to estimate future vast developments.

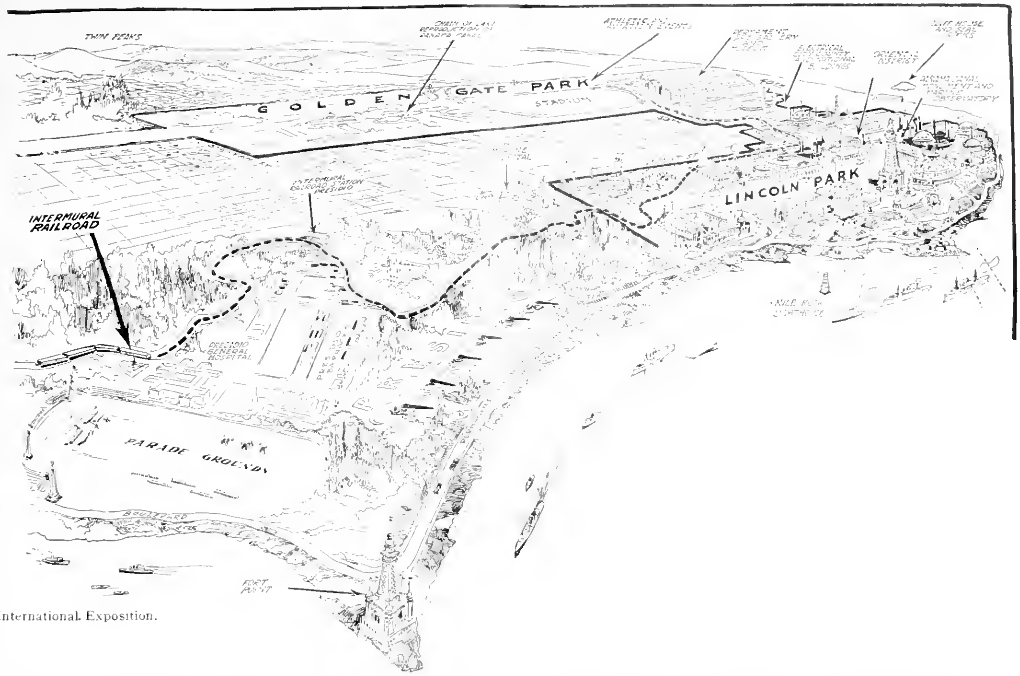
Since its first amazing development of electricity from the fall of Sierra streams California has steadily progressed in the utilization of this natural power until today the supply of electrical power is secured practically as rapidly as it is needed for the expansion of the industries of the state.

The rapid development in the long-distance transmission of power, as well as the great magnitude of the transmission industry in California, was traceable to the absence of known coal deposits in this state at the time when power began to be needed in industry. The price of mechanical power was correspondingly high. Since California turned its engineering effort to the water-fall as the most promising source of energy, fuel oil has been developed in abundant commercial quantities and it, too, is used in the generation of electrical power.

With these two favoring circumstances, the generation of electrical power from Sierra streams and also from crude petroleum, the cheapest and most easily handled fuel, those who have charge of the electrical division of the Exposition will have for the spectacular night displays an abundance of cheap power, an important consideration where much power is to be used.

While contributing little that is material to the advancement of science, the night illuminations will be the permanent dazzling feature of the Exposition and an effort will be made to render them artistic.

The plans for the Exposition site and the adornment of San Francisco lend themselves to superb electrical effects. Imagine, for instance, how a brilliant spectacle will be afforded from San Francisco Bay at night when Telegraph Hill, 287 feet high and abruptly rising above the water front, is illuminated with incandescents; when the Harbor View site of the Exposition with its planned yacht harbor is brilliantly illuminated, and when Lincoln Park, towering above the Golden Gate and the supreme observation point of the entire site, sparkles with light. The boulevard connecting these points will necessarily be illuminated and from a great distance the outlines of the prominent landmarks of the Exposition will be clearly defined. At Lincoln Park will be erected a huge commemorative statue welcoming ships to the Golden Gate and in its general import corresponding to Bartholdi's



International Exposition.

Statue of Liberty in New York harbor. This statue will lend itself to strings of light, as also will a lofty wireless tower that will surmount Telegraph Hill. The whole will be a magic fairyland. Indeed ,the decoration of the prominent observation points gives play for the highest artistic conceptions and it is planned that to observers both near and far the electrical decorative effects shall convey the spirit of the Exposition.

Market Street and Van Ness Avenue, the main boulevards of San Francisco, which, running from San Francisco Bay, meet in an apex in the geographical heart of the city, will be brilliantly illuminated and, although being in the heart of San Francisco, these thoroughfares do not afford the artistic scope that is permitted by such rugged outlines as Telegraph Hill and Lincoln Park, yet they will give a chance for the most novel electric lighting effects. To sum up—it is planned to make the night illuminations the most brilliant and pleasing the world has known and the many eminences available will stand out in silhouette through brilliant chains of light. When the Exposition opens, the illumination of the battle-ships of the world, assembled in San Francisco Bay, will contribute to the striking effect.

Aside from the general electrical lighting effects of the Exposition as a whole there will be an electrical exhibit building, such as the Palace of Electricity at the Universal Exposition held at St. Louis. Because of the marvelous advance made in the application of electrically conveyed energy to industrial undertakings the electrical exhibit promises to be one of the great centers of attractions at the Panama-Pacific International Exposition. It was suggested by the special committee on sites, whose report was unanimously adopted, that the electricity building be located in the two hundred acres of privately owned land between Lincoln Park and the Golden Gate Park site. Here also will be the foreign buildings and machinery in action from foreign countries will be shown. Indeed, the large number and variety of operating exhibits will render the electrical building most instructive and entertaining to the layman.

The largest classification both in area of space and number of exhibits will, necessarily, be that of the machines for generating and using electricity. Dynamos and motors of all the principal makes, both alternating and direct current, will be on exhibition, most of them running. Motor-generators, rotary converters, transformers, rheostats and regulators of every form will be so arranged and connected as to demonstrate their various functions. At the Pan-American Exposition in Buffalo ten years ago one of the most attractive of all the exhibits was the Niagara Falls Transformer plant, a plant having a capacity of 5000 horsepower, consisting of 250 Kilowatt air blast transformers for transforming the power from Niagara Falls delivered at 11,000 volts for distribution about the grounds by means of smaller electric transformers at various points. Near this transformer plant was a working model of the wonderful creation of the Niagara Falls Power Company. No doubt in 1915 a much larger transformer will have been erected at the Panama-Pacific International Exposition supplied with the vast energy of the Sierra streams.

Of the greatest interest and of the highest practical value to the miners of the West will be exhibits of the latest developments in electrically run drills, hoists, fans and other apparatus, while the application

of electrical power in the exhibits representing the production of chemical products such as aluminum, carborundum, carbide of calcium, cyanide of potassium, bleaching powders and other compounds will afford the manufacturer many helpful and inspiring ideas.

In connection with mining, the operation of the huge gold dredgers of California from the power of Sierra streams should afford an example of one of the most unique and economical methods. When it is appreciated that one man at levers is able to direct the workings of the largest dredge in the world, gold dredge Folsom No. 8, the simplicity of electrically handled dredges may be inferred.

Of tremendous popular interest will be the exhibits illustrating the use of electricity in the form of direct, alternating and intermittent current for the treatment of many forms of diseases, especially chronic cases which have been especially refractory. The use of electricity is widely recognized by physicians of great standing. Indeed, it is probable that no branch of therapeutics has made greater advance than the electrical. The electrical therapeutic apparatus will, of course, include X-ray tubes for physical treatment and for diagnosis, and the Finsen lights which give off actinic or higher light rays and are especially efficacious in the treatment of certain diseases.

In the field of the wireless telephone and especially of wireless telegraphy marvelous exhibits are assured. The directors are planning that there shall be built on the summit of Telegraph Hill the tallest wireless tower that can be constructed. From this tower messages will be signalled to ships passing through the canal. Captain Evelyn Briggs Baldwin, the noted Arctic explorer, expects to set forth from San Francisco in 1913 with two especially constructed ships that will drift with the pack ice from a point north of Behring Straits over or very near the North Pole. Captain Baldwin plans a complete wireless outfit and there is a possibility that if he is unable to communicate directly with the Telegraph Hill station he may send messages to the government stations in Alaska, or the Swedish stations on the coast of Spitzenbergen. It is, therefore, within the range of possibility that his observations of the Polar seas will be chronicled upon the very days that they are made.

A large number of inventions in the line of electric lighting have been made in recent years and these will all be demonstrated in a way which will be exceedingly attractive to the public. Arc lamps of every kind and incandescent lights of every size and color will be displayed. The marine boulevard connecting the principal sites of the Exposition, the chain of lakes in the west end of Golden Gate Park connected to a working model of the Panama Canal, the various cascades and the yacht harbor at the Harbor View site of the Exposition are subjects of illumination. The Cooper Hewitt vapor arc lamps may be used [illegible] where it is desired to illuminate water effects such as the miniature Panama Canal, fountains or waterfalls upon the grounds. These lamps emit an [illegible] white light which in the absence of red rays gives a very peculiar effect. Vacuum tube lighting by means of induced currents will also be shown.

In the electrical building special laboratories with complete sets of recording instruments whereby the juries of award and exhibitors may conduct careful and accurate tests upon every kind of electrical apparatus will be installed. The personal judgment of the judges will be reduced to a minimum.

All in all, it is planned to make the electrical features of the Panama-Pacific International Exposition the most comprehensive ever assembled in the world's history. The State of California has assured larger funds than have ever been at the disposal of an exposition at an initial stage and with ample funds and extraordinary interest displayed in the Exposition in all parts of the world, the finest exhibits from exhibitors of this and foreign nations are assured. The Exposition authorities plan that the electrical features of the Exposition itself shall be unsurpassed and they invite the hearty co-operation of the electrical engineers and manufactories of the world. Mr. Edison will be invited to participate in the Exposition and exhibit not only his most recent inventions but those which have the highest value from an historical view point. Among the inventions of the greatest popular interest will no doubt be the storage battery for street car use.

Expositions both in this country and Europe have marked each great step in the advance of high potential practice and the Panama-Pacific International Exposition is to be no exception. The phenomena of high potential currents will be shown beyond anything in this line attempted in previous expositions. While proper safeguards will be thrown about such demonstrations yet they will be made in such a way that the general public as well as electrical engineers may profit by them.

Returning to the field of electro-chemistry: many new processes have lately been developed into commercial possibilities. Electrical furnaces and chemical process in operation would be of the greatest interest and value to the West. The use of electricity in treating ores, when adequately illustrated, will be of immeasurable practical benefit to the mining interests of the West, where there are millions of tons of ore to be developed. The products of the electric furnaces are, as a rule, much purer than the products which are made in any other way and it will be of interest to the public to see the operation and the chemical changes which go on under the influence of the electric arc.

Aside from the great display of machinery and apparatus for generating and using electricity there will be shown electric measuring instruments, apparatus for rapid telegraphy, mechanical apparatus for reproducing sound, electric clocks, motors, starters and controllers, storage batteries, dry batteries, prismatic reflectors, arc lights, illuminated signs, electric headlights and searchlights and the thousand and one devices with which the layman as well as the engineer is familiar.

The Panama-Pacific International Exposition will mark the progress of the world in the advance of the use of electricity and will point the way to the future.

PRIMER OF APPLIED THERMODYNAMICS.[1] FOURTH LECTURE.

Three Physical States of Matter.

The number three seems to pervade all nature. The triune Deity, the three Fates, "the third time is the charm," and a thousand daily occurrences bring this to mind. In the animal kingdom we find a beautiful and striking illustration. The larva, then the catapillar, next the butterfly—three distinct forms. The organism in each case seems to be almost unrecognizable when changed into the other.

Were it not for its exceedingly common occurrence, the three physical states of matter would be perhaps the most wonderful operation of the magic three known to our natural experience. We shall now take the most common substance of all and trace its changes from the solid to the liquid, and then to the gaseous state and see the role that heat forces or principles of thermodynamics play in bringing about these physical changes.

Let us suppose we have before us one pound of ice at 0° F. We now begin to heat the ice, raising its temperature finally to 32° F., which we have found is its melting point. It has required a definite amount of heat to raise the ice to this temperature, nearly ½ B.t.u. for each degree. At 32° F. a peculiar thing happens. We continue to apply heat, but no change in temperature occurs until an additional 144 B.t.u. are added when we find that the ice has been entirely melted into a liquid which we call water. We now continue to apply heat and once again we find that the temperature begins to rise; this time, however, almost twice as much heat in proportion to the amount for the ice is required to raise the temperature one degree. In other words, practically 1 B.t.u. per degree is required. Upon continuing to supply heat, the temperature continues to rise till 180 B.t.u. have been supplied, and consequently the temperature of the water has become 212° F. under ordinary conditions of atmospheric pressure. At this point once again we continue to apply heat. Then it will be found the temperature is not altered until we have this time supplied the enormous amount of 970.4 B.t.u. when it will be found that the entire pound of water has disappeared in the form of a vapory gas known as steam. If now, we have the steam cooped up so that it can be held together, once again we can supply heat and once again the temperature will begin to rise and once again the quantity necessary for each degree is different.

The first condition above cited is familiarly known as the solid and the heat applied is known as sensible heat. When the heat is applied to the melting ice without raising its temperature, the heat energy is said to become latent and the quantity necessary to melt one pound of ice is known as the Latent heat of Fusion. Again, when the ice has been entirely converted into the liquid state or water and heat again applied until its boiling point or point of ebullition is reached, this particular heat applied is known as sensible heat. At this point latent heat is again necessary to evaporate the water and change it from the liquid into the gaseous state. The amount of heat necessary to be supplied in this case is known as the latent heat of vaporization. In the case of water Henning has given the following equation:

$$r = 141.124\ (689 - t)^{0.31249}$$

in which r is the latent heat of vaporation and t the temperature in Fahrenheit degrees.

In engineering practice, except in calculations for cold storage plants, we do not make use of water or ice below 32° F. Hence our steam table computations use 32° F. as the starting point. In the vaporization of any liquid, then, that quantity of heat which is absorbed in raising the temperature from 32° F. to the temperature of ebullition corresponding to the particular pressure at which vaporization occurs is the sensible heat of the liquid, and in engineering practice is known as the "heat of the liquid."

In our illustration above we assumed that the boiling point of water was 212° F. This is true under ordinary atmospheric pressure. The boiling point, however, is a variable quantity, and it is most essential that at this time we straighten any difficulty or lack of clearness we may have regarding this feature.

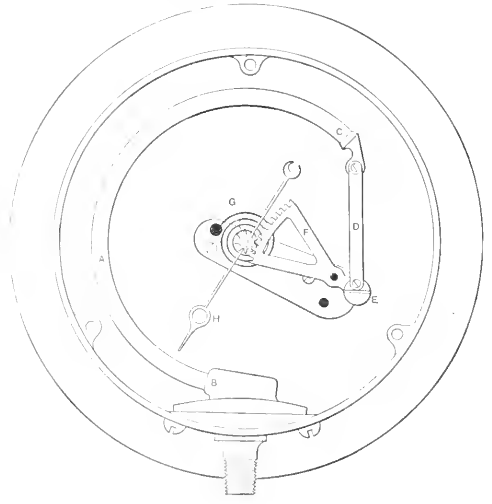


Fig. 11.

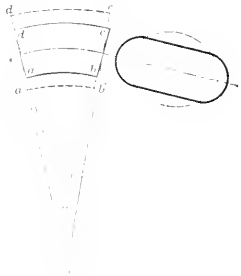
It is the experience of mountaineers that on very high mountains, it is difficult or next to impossible to boil eggs, because the water does not get hot enough or, in a word, the water boils far less than 212° F. on a high mountain. Evidently, then, atmospheric pressure is the determining feature. That this is true can be shown in a physical laboratory, for by still further reducing the pressure, water can be practically made to boil at its freezing point. In fact some physical substances do actually change from the solid to the gaseous state without the intervening liquid change. This is known as sublimation. The important point to recall so far as water is concerned and its engineering application in thermodynamics, is that the varying of the boiling point due to pressure necessary varies the heat of liquid necessary to raise the temperature of the liquid to evaporation. Under atmos-

[1]A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

pheric conditions we have seen that this requires 180 B.t.u., but it will be proportionately more or less according as the pressure is more or less than atmospheric pressure; that is, 14.7 lb. per sq. in.

The question of pressure, then, has introduced another cardinal property of matter with which it will be necessary for us to concern ourselves in the study of thermodynamics. A cardinal or integral property of a substance is any property which is fully defined by the immediate state of the substance. Any two or three cardinal properties of a substance may be used as coordinates in a graphic representation of the state of the substance. In the study of thermodynamics we concern ourselves with six cardinal properties of matter. In addition to pressure, volume, and temperature, we shall later study internal energy, entropy, and, for wet vapors, dryness. The first general principle of thermodynamics is that if two of the three named cardinal properties are known, these two enable us to calculate the third.

In practice, pressures are measured largely by means of a so-called Bourdon pressure gauge. A Bourdon pressure gauge, shown in Fig. 11, is used to indicate the steam pressure. The tube A is formed from a circular tube which has been flattened until the cross-section is similar to that shown in Fig. 12 as illustrated and explained by Spangler, Greene & Marshall in their excellent little book entitled Elements of Steam Engineering. The tube is then bent into an arc of a circle and the end attachments brazed on. If the tube were circular in section the application of an internal pressure would not cause any movement of the ends. If the tube has a flattened section and pressure is applied, the ends will move outward to a larger radius.



Fig

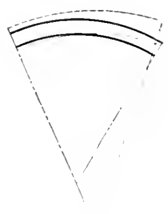


Fig. 13.

The action of such a tube can be seen from a consideration of a portion of the tube adcb, shown in Fig. 12. The lines ad and bc represent cross-sections of the tube perpendicular to the center line. The intersection of these lines determines the center O of the circle to which the tube has been bent. If internal pressure be applied to the tube, the flattened surfaces open out, ab taking the position a'b' and cd the position c'd'. These lengths are not materially changed by this action and a'd' and b'c' are the new positions of the sections considered. Continuing these lines gives the new center O' of the arc of this portion under the new conditions. Since the section considered is any section, the action is the same for the whole tube, and as the radii are larger, the free end of the tube must have moved outward, as shown in Fig. 13. Hence by proper graduations an accurate gauge is easily devised.

Practically all of the pressure gauges used in practice read above atmospheric pressure, or, in other words, to get the real or absolute pressure, 14.7 lb. per sq. in. must be added. The use of condensing engines has necessitated the employing of some device to read pressures below atmospheric pressure. A very cumbersome device, or rather a cumbersome scale, is employed, but since it is the one in common use we must look into its make-up. Now it is found that a column of mercury 29.6 inches high will just balance the atmospheric pressure. A column of mercury 1 sq. in. in section and 29.6 inches high weighs 14.7 lb. Hence 29.6 inches of mercury are equivalent to 14.7 lb. pressure. If now a pressure is measured which shows but 19.6 in. of mercury, evidently the pressure has been reduced by 10 inches, or we say 10 in. of vacuum exists. Since 29.6 in. of mercury correspond to 14.7 lb. pressure, evidently each in. of vacuum represents very approximately a reduction of ½ lb. below atmospheric pressure. It is of the greatest importance in speaking of pressure that you should be sure whether your starting point is atmospheric or absolute, and then base your computations accordingly.

In speaking of the rise in temperature of a substance, the amount of heat required to raise its temperature, 1 degree Fahrenheit is called its specific heat. We shall find that this amount of heat varies widely for different substances, and in fact varies somewhat in each substance for different temperatures. In the case of water, for example, we speak of its specific heat as being unity, while to be exact, its specific heat according to Regnault is as follows:

$$\text{Specific heat} = 1 + 0.0004\ t + 0.0000009\ t^2.$$

In which t is the temperature in Centigrade scale.

For the case of solids and liquids a list illustrative of the various specific heats of substances is appended. We shall reserve the question of specific heats of gases until a later lecture. It is observed that water has the highest specific heat of all liquids, hydrogen gas being the only other substance of greater heat absorbing capacity. A general law is also seen that the specific heat becomes greater in the liquid than in the solid and again less in the gaseous state. Aside from the fact that its bountiful distribution in nature makes its use in engineering important as a thermodynamic medium, the large specific heat of water also adds materially as a medium for strong energy.

SPECIFIC HEATS.

Solids.		Liquids.	
Copper	.0951	Water	1.0000
Gold	.0324	Alcohol	.7000
Wrought iron	.1138	Mercury	.0333
Cast iron	.1298	Benzine	.4500
Steel (soft)	.1165	Glycerine	.5550
Steel (hard)	.1175	Lead (melted)	.0402
Zinc	.0956	Sulphur (melted)	.2340
Brass	.0939	Tin (melted)	.0637
Glass	.1937	Sulphuric acid	.3350
Lead	.0314	Oil of turpentine	.4260
Platinum	.0324		
Silver	.0570		
Tin	.0562		
Ice	.5040		
Sulphur	.2026		
Charcoal	.2410		

The amount of heat required to raise a unit of weight of a liquid from freezing point to a given temperature and to vaporize it into dry saturated vapor against the corresponding temperature is called the

total heat. Now it is evident from this definition and from the definition of heat of a liquid previously given in this lecture, that the total heat of vaporization is equal to the sum of the heat of the liquid and the heat of vaporization; if the first is represented by q and the latter by r then H, the total heat, is given by the following equation:

$$H = r + q.$$

Dr. Harvey N. Davis gives for the total heat of steam in B.t.u. per pound,

$$H = 1150 + 0.3745\ (t - 212) - 0.000550\ (t - 212)^2$$

in which t is the temperature in Fahrenheit degrees.

The Economizer.

As an application of the heat of a liquid being used in engineering practice to increase the economy of a steam plant we shall next consider the so-called

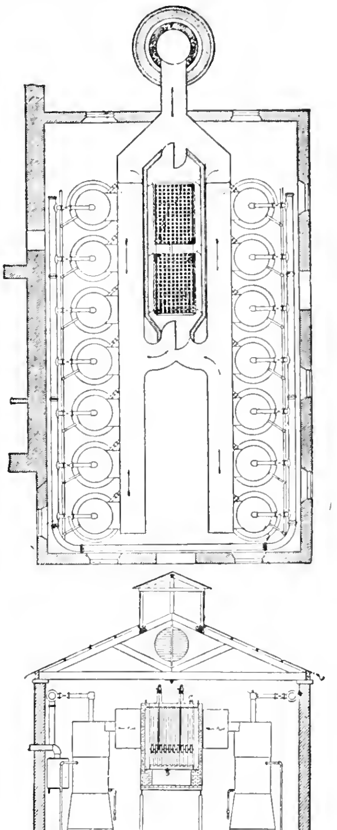


Fig. 14. Green Fuel Economizer.

Economizer. In our last lecture we found under the study of fuels that in spite of every care we may use in the combustion of fuel, still an enormous number of heat units passed up the chimney unutilized. It is evident, then, if some method can be devised to still further absorb the heat of the out-going chimney gases a real saving can be made. Chimney gases usually pass up the flue at a temperature of about 500° F. We have just seen that a certain amount of heat is required to raise the temperature of feed water to the vaporization point, and in a previous lecture we found that the greater the difference in temperature two surfaces are relative to each other when placed in contact the more readily will the warmer element part with its heat. If now we can bring the cool feed water in contact with the hot outgoing gases an economy can be brought about by still further reducing the temperature of the flue-gases, thus causing them to part with considerable heat that would otherwise be wasted. Such a device is known in engineering practice as an Economizer. By a careful installation an Economizer may be made to heat the feed-water as high as 300° F. or more, whereas no ordinary exhaust-steam heater, which we shall later study, can possibly produce a temperature higher than 212° F. It is evident since the specific heat of water is very close to unity, the gain by heating feed water is about 1 B.t.u. per pound of steam for each degree heated; or since the average steam contains 1000 B.t.u. net as we shall later find, the gain is about 1 per cent for each 10° that the temperature is so raised. To be exact the gain is $\frac{H - h}{Q}$, in which Q is the total heat of the steam gained from the temperature of feed to the state at evaporation and h and H the total heats in the water before and after heating. Now if t_c and t be the temperatures of the flue gases and steam, respectively, W the weight, and S the mean specific heat of the chimney gases (usually about 0.24), the maximum saving that can be effected by a perfect economizer is $WS\,(t_c - t)$. Good operation decreases W and t_c and thus makes the possible saving small.

A typical economizer installation is that shown in Fig. 14, which is known in the trade as the Green Fuel Economizer. In order that the economizer may be inspected and cleaned from time to time an arrangement is always made for by-passing the gases. The device consists of vertical castiron tubes with connecting headers at the ends, the tubes being sometimes staggered so that the gases will impinge against them. The external surface of the tubes is kept clean by scrapers, operated from a small steam engine. The tubes obstruct the draft, and some form of mechanical draft is employed in conjunction with economizers. About 4.8 sq. ft. of economizer surface are ordinarily used per boiler horsepower.

THERMOTWISTERS

1. A boiler evaporates 3000 lb. of water per hour from a feed-water temperature of 200° F. to dry steam at 160 lb. pressure which corresponds to a temperature of 363.6° F. What is its horsepower?

2. In the above problem what proportion of the whole heat in the fuel is carried away in the flue gases, if their temperature is 600° F. assuming the specific heats of the gases to be constant? The initial temperature of the fuel and air supplied is 0° F.

3. In the second problem, what would be the percentage of saving due to an economizer which reduced the gas temperature to 400° F?

SOLUTION OF THERMOTWISTERS FOR FIRST LECTURE.

1. The normal temperature of the human body is 98.6° F. Express in Centigrade and Reaumur degrees.

Substituting in formulas 1 and 3, page 209, and solving for C, we have

$$F = 9/5\,C + 32 \text{ or } 98.6 = 9/5\,C + 32$$
$$9/5\,C = 66.6 \text{ or } C = 37.0 \quad \text{Ans.}$$

$$R = 4/9\ (F - 32) \text{ or } R = \frac{4}{9}(98.6 - 32)$$

$$\text{or } R = 29.6° \quad \text{Ans.}$$

2. Compute by equations given above at what temperature the Fahrenheit and Centigrade scales read alike. Similarly for the Fahrenheit and Reaumur scales.

Evidently the scales will read alike when $F = C$ in the equation $F = 9/5\,C + 32$, hence substituting $F = C$, we have

$$C = 9/5\,C + 32, \text{ or } C = -40° \quad \text{Ans.}$$

Similarly in the second case, R must equal F in the equation $R = 4/9\ (F - 32)$, hence substituting $R = F$, we have

$$F = 4/9\ (F - 32) \text{ or } F = -25.6 \quad \text{Ans.}$$

3. Given that $y = mx + b$ is an equation which represents in general the three thermometer scales in which y or x can be either F, C or R. Compute the two constants m and b by substituting corresponding values on scales for boiling and freezing point of water and thus deduce for yourself the three equations above.

(1) In the Fahrenheit-Centigrade relationship—

At freezing point of water $F = 32$, $C = 0$. Hence substituting in $y = mx + b$, we have when $y = F$ and $x = C$

$$32 = m\,0 + b, \text{ or } b = 32$$

Again at boiling point of water $F = 212$, $C = 100$. Hence substituting, we have

$$212 = m\,100 + b = m\,100 + 32, \text{ or } m = 9/5$$

Therefore in $y = mx + b$, we have

$$F = 9/5\,C + 32 \quad \text{Ans.}$$

(2) In the Centigrade-Reaumur relationship—

At freezing point of water $C = 0$, $R = 0$. Hence substituting in $y = mx + b$, we have, when $y = C$ and $x = R$

$$0 = m\,0 + b, \text{ or } b = 0$$

Again at boiling point of water $C = 100$, $R = 80$. Hence substituting, we have

$$100 = m\,80 + b = m\,80, \text{ or } m = 5/4$$

Therefore in $y = mx + b$, we have $C = 5/4$ Ans.

(3) In the Reaumur-Fahrenheit relationship—

At freezing point of water $R = 0$, $F = 32$. Hence substituting in $y = mx + b$, we have when $y = R$ and $x = F$

$$0 = m\,32 + b, \text{ or } b = -32\,m \quad (a)$$

Again at boiling point of water $R = 80$, $F = 212$. Hence substituting, we have

$$80 = m\,212 + b, \text{ or } b = 80 - 212\,m \quad (b)$$

Eliminating b from (a) and (b), we have

$$-32\,m = 80 - 212\,m, \text{ or } m = \frac{4}{9}. \text{ Hence } b = -4/9 \times 32$$

Therefore in $y = mx + b$, we have

$$R = 4/9\,F - 4/9\,32, \text{ or } R = 4/9\ (F - 32) \quad \text{Ans.}$$

NINETEENTH ANNUAL CONVENTION PACIFIC COAST GAS ASSOCIATION.

It was a notable gathering that met in Oakland during the past week and one that will long linger in the memories of all those who attended the sessions of the annual convention of the Pacific Coast Gas Association.

Delegates to the nineteenth annual convention of the Pacific Coast Gas Association gathered at Foresters' Hall, Thirteenth and Clay streets, Oakland, at 10 o'clock a.m., September 19th, and took preliminary steps toward the establishment of a gas engineer degree at the University of California. The sum of $6000 was subscribed by members of the association, who agreed to pay pledges in five annual installments until the required sum has been entirely paid up. John A. Britton of the Pacific Gas and Electric Company, secretary-treasurer of the association, originated the idea.

In point of attendance the convention was the largest which has ever been held in the history of the association. Frank A. Leach, Jr., manager of the Oakland Gas, Light and Heat Company, called the meeting to order as president of the association. A large delegation of Southern California gas men carried large gilt buttons in their lapels announcing that San Diego aspired to the annual convention next year.

Because of its inactivity, the committee appointed at the last convention of the association to prepare for a national convention in San Francisco in 1915 was dissolved, and John A. Britton, as secretary, read a copy of an invitation issued by the gas corporations of the Pacific Coast to the officials of similar concerns throughout the country to attend a national congress in San Francisco during the time of the Panama-Pacific Exposition. John A. Britton, Leo A. Lowe, W. B. Cline, John Martin and George H. Collins were appointed to look after the affairs of the national gathering to be held here in 1915.

Leach, in his opening address, talked of the new corporation tax, and also spoke strongly against the employers' liability act and gave a general discussion of the various amendments which affect the gas men, and which will be voted on at the coming election next month.

The sessions of the convention continued to Thursday evening. Wednesday was devoted to another business session, when a series of papers were read. At 7 o'clock Wednesday evening a banquet was served to the delegates at the Key Route Inn. On Thursday the delegates made a tour of Oakland, including the inspection of the Standard Oil Works at Richmond. Luncheon was later served at Piedmont Park.

At the banquet on Wednesday evening John A. Britton appeared as the amiable toastmaster of the occasion. The jovial stunts of John F. Parker and E. T. Van der Naillen, the former as songmaster and "jollier," the latter as burlesque councilman and "Portugee," kept the banquet in a roar throughout the entire evening.

Taking it all in all the nineteenth annual gathering of the Pacific Coast Gas Association will go down into history as the most profitable and pleasant gathering ever undertaken by the organization.

The entire papers presented at the convention will appear in the columns of the Journal and will commence in the following pages.

The papers read at the convention are as follows:

President's Address..............Frank A. Leach, Jr.
Unstable Hydrocarbons in Illuminating Gas..... ....E. C. Jones
Suburban Gas Distribution...........C. S. S. Forney
Rate Fixing.........................Prof. C. L. Cory
The Napthalene Problem in Oil Gas Manufacture and Distribution.....................F. S. Wade
Early Gas Lighting..................W. R. Morgan
Mechanical Handling of Carbon By-Products of the Oil Gas Process................D. J. Young
The Gas Meter........................W. M. DuVal
Measures Employed to Decrease Complaints of Customers.............San Diego Gas Company
Wrinkles..............................F. C. Millard
Experiences.........................John D. Kuster
Novelties...........................John Clements

The officers for the Pacific Coast Gas Association elected at the meeting Wednesday are William Baurhyte, president; H. E. Adams, vice-president; J. A. Britton, secretary; H. Bostwick, assistant secretary. The directors are H. C. Keys, C. S. Stants, S. W. Coleman, H. H. Jones, C. Halbertion and R. Thompson.

PRESIDENT'S ADDRESS.

BY FRANK W. LEACH, JR.

As president of the Pacific Coast Gas Association and as a citizen of Oakland, I am very pleased to welcome you here this morning in our Nineteenth Annual Convention.

The year just finished has been one of great activity and importance to the gas and allied industries on the Pacific Coast. There has been an ever-increasing demand for our commodity. New avenues for output have been opened and established sources of income enlarged. The field for industrial appliances continues to increase and it is now the exception to find a factory, laundry or workshop that is not using gas in some part of its operation.

There has been an increasing demand for gas for illumination notwithstanding the great improvement in electric incandescent lamps during the past year. The introduction of high-efficiency electric lamps with their long white rays have popularized the brilliant white light of the gas arc and other mantle burners. The manufacturers of gas arcs have kept pace with the improvements of electric manufacturers and there is today a strong demand for this form of illumination.

Light is popularly judged by comparison; artificial light is compared with sunlight, one artificial illumination with another. And gentlemen, from my observation of present day gas illumination, we, as gas men, have no apologies to make, nothing to fear; simply to send out our solicitors and the business is ours.

There has been introduced a new inverted double burner for street illumination which is being installed in this city with great satisfaction. Already approximately 500 have been installed and 200 more have been ordered. They are being placed in the thickly settled residence districts where the sidewalks are lined with shade trees and where the old form of street lighting by electric arcs 3[illegible] feet apart was practically useless. Thus not only are new avenues of revenue opening to us, but also are we again coming into our own.

The extensive development of the oil fields has continued. New gushers have been brought in, many supplying enormous quantities of gas at great pressure. This gas has been conserved in a very limited way to date. Only a few small towns in the immediate vicinity are supplied, although a considerable quantity is being used under boilers in the fields. Reports have come from time to time that the gas wells were already showing signs of giving out; but experienced gas men from the Eastern fields say they look for large development of this branch of their industry in the near future. The development of many individual producers of varying quality of oil has caused much concern to the gas companies buying from distributing companies. The difference in gravity and impurities is sufficient to cause great inconvenience in manufacture.

The advance in manufacture has been confined mainly to refinement in our well established systems of oil gas which have come into general use in California. The use of residual carbon in the manufacture of carbureted water gas has been demonstrated a success and it is now possible to regulate the production of carbon within the limits of its use for that purpose.

Under Senate Constitutional Amendment No. 1, adopted October 5, 1910, becoming effective January 1, 1911, and approved by the citizens of California under the Act of the Legislature (Chapter 335, approved April 1, 1911), the entire system of taxation for state purposes has been changed.

Section 1 sets forth: "Taxes levied, assessed and collected as hereinafter provided upon railroads, including street railways, whether operated in one or more counties; sleeping car, dining car, drawing-room car and palace car companies, refrigerator, oil, stock, fruit, and other car-loaning and other car companies operating upon railroads in this State; companies doing express business on any railroad, steamboat, vessel or stage line in this State; telegraph companies; telephone companies; companies engaged in the transmission or sale of gas or electricity; insurance companies; banks, banking associations, savings and loan societies, and trust companies; and taxes upon all franchises of every kind and nature, shall be entirely and exclusively for State purposes, and shall be levied, assessed and collected by the State Board of Equalization, and collected in the manner hereinafter provided. The word 'company' and the word 'companies' as used in this section shall include persons, partnerships, [illegible] companies, and corporations. [illegible] railroad companies, including [illegible] whether operated in one or more counties; [illegible] dining car, drawing-room car [illegible] companies, all refrigerator, oil, stock, [illegible] car-loaning, and other car companies [illegible] railroads in this State; all companies [illegible] on any railroad, steamboat, vessel [illegible] in this State; all telegraph and telephone [illegible] and all companies engaged in the [illegible] gas or electricity shall annually [illegible] upon their franchises, roadways, [illegible]

panies engaged in the transmission or sale of gas or electricity, four per cent. Such taxes shall be in lieu of all other taxes and licenses, State, county, and municipal, upon the property above enumerated of such companies except as otherwise provided in section fourteen of article thirteen of the constitution of this State, and as provided in section twenty-two of article four of said constitution.

"The word 'municipal' as used in this act shall apply to incoropraied towns and cities formed under article eleven of the constitution of this State and to none other."

The preparation of reports required by the State Board of Equalization entailed a great burden upon the companies coming within the law and the 4 per cent of gross receipts assessed to gas and electric companies has added materially to the total taxes paid. The total receipts of these companies in California for the year ending December 31, 1910, was $30,458,313, producing over $1,200,000, over 10 per cent of the total amount of taxes raised for State purposes.

On September 1, 1911, Senate Bill No .14 passed by the Legislature went into effect, relating to the liability of employers for injuries or death sustained by their employees, providing for compensation for the accidental injury of employees, established an industrial accident board to be appointed by the Governor, making an appropriation therefor, defining its powers and providing for a review of its awards.

The terms of this Act are yet optional so far as assuming the fixed basis of compensation is concerned. The act fixes the amount to be paid in all cases from slight injuries to death. (But nothing is allowed if the period of disability does not last more than a week.) All disputes between injured workmen and their employers are to be adjusted by an "Industrial Accident Board" to be appointed by the Governor. Appeals lie to the Superior Court and then to the Supreme Court, but only as to the question of fraud and to the sufficiency of the facts to support the findings of the Board. All such appeals are to be given preference on the court calendar. But whether accepted or not, the old defenses of contributory negligence, assumed risk and negligence of fellow servants, are repealed. In other words, if an employer chooses to place himself within the act, his responsibility and damage are clearly determined thereby; if he does not, he must defend himself in ordinary actions at law, but without the defenses above named, and without limit as to how much a jury may award in damages. The only negligence of the employee which will bar recovery is "willful misconduct."

At our next election in October, an amendment will be placed before the people to remove the optional phase of the act, and make the acceptance of the fixed compensation compulsory. This form of legislation has become popular, not only in California, but in many other States. There is no doubt that all concerned would be greatly benefited by regulations which would procure for the injuried a larger portion of the amount paid by the employer. At present, much less than 50 per cent reaches the injured. The balance is consumed in expenses. Much anxiety has been felt by employers on account of the act; but just how great a burden it may prove to be is yet to be demonstrated.

At our last meeting President Cline called attention to the desirability of a Public Service Commission for the State of California along the lines of those established by other States. Two amendments to the consideration have been approved for submission to the people in October—Assembly Constitutional Amendment No. 6 enlarging the number of Railroad Commissioners to 5, and Senate Constitutional Amendment No. 47 enlarging the powers of that Commission. This makes it optional for cities by majority vote to retain unto themselves the right to regulate public utilities as heretofore and also to recover such right even after it has been surrendered to the State Railroad Commission.

It is to be regretted that California cannot have a Commission with complete control similar to the other progressive States where so much has been accomplished. The State of Nevada has adopted and is now working under a Public Service Commission very similar to the Wisconsin Commission and, although its field of labor is limited, it is handling the problems in a progressive manner.

The absolute necessity for such a Commission is demonstrated in Los Angeles's experience. Their Local Board of Public Utilities clothed with extraordinary powers, was repudiated by the City Council in its desire to meet with popular approval after exhaustive investigation and report by high-priced experts.

The settlement of the San Francisco Rate Case by compromise has disposed of the most important litigation of interest to gas men. There have been many minor cases of damage, etc. The California District Court of Appeals, 115 Pac. 754, Fair vs. Nome Gas & Electric Company, has sustained the findings of the Lower Court upholding the provisions of Section 629, California Civil Code, regulating the furnishing of service when the consumer is within 100 feet of the main.

The labor situation, so far as the gas industry is concerned, has been very satisfactory during the last year. The wonderful growth of all the cities on the Coast has required very extensive construction work, keeping large numbers of men employed during the entire year. While the agitator is always with us, I believe there exists a better feeling between the gas companies and their men than in almost any other calling.

Pursuant to instructions given at the last convention, a committee was appointed for the purpose of arranging for the Congress of Gas Men to be held in San Francisco during the Panama-Pacific Exposition in 1915. Invitations to participate have been sent to the General Associations and I believe a continuance of our effort will result in the greatest gathering of gas men ever convened.

At this time I wish to thank the officers of the Association for their hearty co-operation during the year, and especially in preparation for this convention. I also desire to thank those who have generously given their time in the preparation of the papers to be read before this meeting. Subjects of most vital importance are before us and I trust that all present will take an active part in their discussion.

THE GAS METER.

BY W. M. DU VAL.

I want to begin by saying that I am indebted to Mr. William McDonald of Albany, N. Y., for much of the data contained in this paper.

From the time James Murdock in 1792 first manufactured gas for commercial, or as King says, for economical purposes, until about the year 1820, there was no way of ascertaining how much gas was used, excepting by counting the number of burners used and guessing at the amount each burner consumed per hour, or some other period.

This proved a very unsatisfactory way of selling gas, as the unscrupulous consumer always got the best of it, and the honest one the worst, and it is a fact that until some method of measuring gas was obtained all attempts to sell gas commercially were financial failures.

So those engaged in the manufacture and sale of gas soon realized the necessity of securing some instrument that would inform them how much was being used, and set themselves seriously to accomplish what must have seemed to them an exceedingly difficult task.

It is not the intention here to undertake to describe the mechanical details of these first attempts at meter making, as they are fully described in King's "Treatise on Coal Gas," and so far as wet meters are concerned, in a paper on Station Meters by Mr. Donald McDonald, of Albany, N. Y., and read at the Congress of Gas Associations in June, 1904.

It may be said briefly, however, that, spurred on by the necessity for a measure of some kind, Samuel Clegg early in 1815 made the first known attempt to make a gas measuring machine. It was a crude attempt and would not work practically. His second attempt was made in December, 1815, and he succeeded so far as to have his measure styled "The First Gas Meter." In 1817 and 1818 Mr. John Malam greatly improved Clegg's meter, and it was again improved and made practical by Samuel Crosley, who became possessed of Clegg's patents in the year 1819 or 1820.

In 1820 the manufacture of wet gas meters was commenced and carried on as a regular business, and the sellers of gas gradually began their use. As an illustration of conditions, I quote the following from the prospectus issued by the Edinburgh Oil-Gas Light Co. in 1824:

"The directors of this company beg leave to announce to the inhabitants of Edinburgh, that they will be ready early in November next, to supply them with a light, which, for brilliancy, cleanliness, and economy, has not yet been equalled."

"To suit the convenience of customers, they have resolved to supply them with meters, through which all the gas passes, and is registered with the greatest accuracy. By this plan the consumers can be charged for no more than the exact quantity consumed, whatever may be the number or description of lights employed by them. Neither are they limited in point of time, but may use the light for a longer or shorter period as best suits them, and may increase or diminish the quantity at pleasure."

The first dry meter was patented by John Malam in 1820, but it did not prove to be of any practical value, and apparently no further attempt was made to secure a dry meter until 1833, when an American named Bogardus, of Baltimore, invented a dry meter which was patented in England by Mr. Bery. In 1836 this same Bogardus invented another machine intended to be a dry meter, but it apparently was never completed. An Englishman named Edge became the owner of Bogardus's first patents, and very much improved the meter, and sold the rights to The Dry Meter Co., London, who made an attempt to manufacture it for sale, but apparently they never succeeded in getting it on the market, as they abandoned its manufacture in a comparatively short time.

About this time Mr. Defries invented what has been known since as the three diaphragm round meter, and eventually a large number of these meters were made and sold, as many of the companies on the Pacific Coast know. The diaphragm used in these meters was, and is still known as the "Defries diaphragm," and up to the time of its invention and manufacture was altogether the best dry meter that had yet been made.

King says that it is not an exaggeration to say that Mr. W. Richards stands in the same relation to the dry meter that John Malam does to the wet. He made it a measuring instrument insuring more regularity in its action and greater accuracy in its registration than any that had been previously made. This meter, which is the two diaphragm meter, was invented by him in conjunction with Mr. Croll in 1844, and with some modifications is today the meter most largely used for measuring gas.

Before leaving the subject of wet meters, however, it should be noted that nothing has ever been evolved that would satisfactorily take its place for certain purposes. As a station meter at the gas works, as a philosophical instrument in the laboratory or photometer room, its place is practically undisputed.

Made as it is entirely of metal on the principle of a screw and charged with water to such a height as to make the meter operative, it constitutes an exact measure, which King truly says, "May be placed among the most beautiful of mechanical inventions," and which as he suggests, establishes an imperishable monument to the names of Samuel Clegg, John Malam, Samuel Crosley and William Parkinson. To these names must now be added the name of C. W. Hinman, of Boston.

Mr. Hinman's achievement was not so much in the line of evolving an original principle in measurement, as it was in the application of the principles which Clegg and Crosley had laid down, but he perfected these principles to such an extent as to constitute original invention along the line of utilizing to a greater extent than ever before the cubical contents of the casing of the meter, and by his arrangement of measuring partitions a drum revolving at a periphery speed at a given loss of pressure not heretofore possible. This invention has been so successful as to make station meters built under his patents practically part of the standard specifications for a gas works in this country.

While the dry meter was invented by Richards and Croll, and manufactured by them, yet it seems to have been Mr. Thomas Glover who improved and simplified and put on the market large quantities of this well-known dry gas meter, and it is known today as the "Glover Two Diaphragm Slide Valve Meter." While many improvements in methods of construction have been made in the past fifty years, the mechanical principles of this meter have proved to be sound and it stands as the best exemplification of a practical consumer's meter, and will probably so remain for a long time to come.

Especially in the past forty years there have been many attempts made to produce measuring devices that would be superior in some features at least, or an improvement upon the two diaphragm slide valve meter, but the writer believes that it can be safely said that no one has yet succeeded in accomplishing this, and it is the opinion of the writer, gathered from as many sources of knowledge on this subject as has been possible for him to reach, that the two diaphragm slide valve meter in a tin plate case will continue to be used for many years to come to measure the great volume of gas made and sold for domestic purposes.

Wet meters had been in use for some time on this side of the Atlantic, when Defries and Richards brought out their dry meters in England. Before relating briefly the story of the making of the first meters in this country, it may be said, that, in a general way the gas companies here found themselves confronted with the same problem that the English gas makers had encountered, in that it was necessary in order to make a financial success of the business, to find some accurate means of determining the amount of gas used by each consumer. At first the gas companies here as in England, attempted either to manufacture their own meters, or were more or less financially interested in the enterprise, but this relation was soon discontinued for the same good reasons that gas companies do not today engage in the business.

The relation between the gas company and its consumers has always been one that required diplomatic handling, and the manufacture of its own meters by the gas company was, and is, inadvisable, if for no other reason than the obvious one that the gas company's position is strengthened by being able to state that the meters by which the consumer's indebtedness to the company is ascertained, are made by disinterested parties, and the consumer may, therefore, be satisfied that the determination of the amount of gas consumed is correct. So, while a few of the early gas companies did, for a time, make some meters, the practice was soon discontinued and the manufacture of meters was begun independently of the gas companies, and has so continued up to the present time.

Not the least of the pleasures of reading history or studying the record of the accomplishments of the past is to find some reference to scenes or incidents which occurred in localities with which the reader is familiar, and particularly when such reference leads to places with which the reader is, or has been intimately associated. Especially is this true when the reference brings back thoughts of home to him who has wandered far in search of success.

So the writer knows he will be pardoned when he states that it was of peculiar interest to him, proud as he is of his Maryland birth and rearing, to find as he browsed among the early records of gas making in this country, that the first practical meter makers in the United States were located in Baltimore. The names of the men who started this enterprise are almost forgotten, and the little shop in Concord Street has long been closed, but inquiry on the writer's part developed the fact that meters bearing the badge of Slaney and Collier, or the Phoenix Meter Co. occasionally turn up in an odd lot sent in for repairs.

Mr. H. C. Slaney contributed a paper to the meeting of the American Gas Light Association in Washington in 1894, in which he gave some details of the early Baltimore meter makers. The first meter was made there in 1832 by James Hill, and he was followed by Mr. John Rogers and by Mr. John M. Slaney, whose son afterwards took in Charles Collier as partner and started the shop in Concord Street in 1848. This partnership was merged into the Phoenix Meter Co., which was liquidated in 1859. In the meantime, and, in fact, shortly after meters had been made in Baltimore, meter making had begun in other eastern cities: in 1836 in New York; in 1837 in Philadelphia; in 1849 in Boston, and in 1855 in Albany.

That there was considerable competition in the business even in this early day would be indicated by the following extract from a paper contributed by Mr. Donald McDonald of Albany, under the head of "Meters and Meter Makers" in the semi-centennial issue of the American Gas Light Journal in 1909:

"In the first issue of this Journal, of which this number is the semi-centenary, there appeared the advertisement of two firms of meter makers; that of Samuel Down of New York, and of Code, Hopper & Gratz of Philadelphia. In Mr. Down's advertisement appears the following paragraph which, read in the light of today, has in it a considerable element of humor. After assuring his prospective customers of the high quality of the meters which he is now producing, he continues with these words: 'He deems it highly necessary to place gas light companies throughout the Union, British Provinces, South America and Cuba, on their guard against all parties who are industriously endeavoring to introduce to their notice patent dry gas meters constructed precisely in imitation of his, but with Chinese-like characteristics, not fully understanding the correct principles upon which they are made.'"

It is not within the scope of this paper to attempt to follow the fortunes of these early establishments, or of the men who were associated with them, except to note that these men have been among those best known in gas circles, and many of them have contributed in no small degree to the substantial progress of the gas business both on the engineering and on the commercial side.

It seems proper that some reference should be made to the subject of prepayment meters, and in looking into this subject the writer finds that the first mention of such a device in the patent office was in 1889, when R. W. Brownhill secured three patents

in this country on a device which he had previously patented in England and in Germany, and which he styled "An Apparatus for Vending Gas." He was quickly followed by Charles Middlebrook, with further patents by Brownhill, and then by Sawyer and Purves, W. Cowan, Damel, Orme, G. Carter, J. Hawkyard, J. Gowe, W. A. Thompson, W. N. Milsted, R. T. and J. G. Glover, and a few hundred others too numerous to mention, two of them being here in California.

The practical manufacture of prepayment meters began in England in 1891 and proved successful almost from the start. The writer is informed that the first prepayment meters sold in this country were made by the American Meter Co. under Parkinson's patents in 1893, but did not prove very successful. Like all new things that succeed, the prepayment meter was a development, and out of the large number of men who tried to invent, or perfect a device for the purpose, only a very few succeeded in making a prepayment meter that by its simplicity and durability commended itself to the gas companies as a satisfactory article. After the first years of experiment and with the discarding of innumerable devices that proved to be useless, two or three types of automatic, or as we call them, prepayment meters, came to be recognized as standard articles on the market, and the prepayment meter has proved to be a great help in obtaining consumers, especially among the middle and poorer classes of people, and there are today a very large number of such meters in use. In a considerable number of smaller manufacturing towns, particularly in New England, the local gas company has a greater number of prepayment customers than any other, and the writer notes in the reports given in Brown's Directory for 1911, that in one New England city the number of meters in use is given as 2,170, of which only 30 are not of the prepayment type. The writer believes that it can safely be said that the consumers that are supplied with prepayment meters are as a class the best satisfied of the gas companies' customers.

I will also refer to the "Complaint" meter, first made by the Maryland Meter Co. of Baltimore, I think about 1890. This meter is so constructed with Seth Thomas Clock as to show clearly to any consumer the amount of gas consumed during each hour, day or night, and is a "shelter in the time of storm" to clerks in the office of many gas companies.

In preparing this modest paper, which the writer looks upon as as a little sermon on the subject with which he is most familiar, he cast about for a text, and he found it in a society magazine under the head of definitions, in which the gas meter was defined as near as memory recalls, as an instrument designed to encourage matrimony by inducing economy in illumination, and to discourage daily baths. Probably the writer of this epigram had no thought beyond that of gaining a smile by taking a fling at a favored target for ridicule, but to the writer there was contained, in this semi-humorous remark, a text that furnished food for thought. It is quite unlikely that to either the ingenious Malam or the industrious Clegg did the thought occur that the meter, which they so patiently tried to perfect so that it would prove to be an accurate measure, would have any relation to the cleanliness of the nation, or, to carry the thought a little further, on the preparation of the world's food supply, and yet such is the case.

The gas that is measured through meters that are the evolution of the creation of Malam and Clegg is largely used to not only light the dark places, but to cook the breakfast, and often times the dinner and supper, of the better part of the civilized world. Yet more, even where civilization has elapsed into the almost barbaric splendor of the lobster palaces of the Great White Way, do we find the Bunsen Burner roasting the canvas-back duck or broiling the toothsome sweetbread, and the more modest highways are dotted with the dairy lunch with the gas heated griddle cooking flapjacks for the million.

And as for baths, the meter man can hardly supply the demand for meters for the measurement of gas sufficient to keep the household comfortable and in hot water. Indeed, a little reflection will show that when the sarcastic writer referred to the meter as a deterrent of bathing, he unconsciously struck a cord that covers the gamut of gas making from 1816 to 1911.

The Pacific Gas & Electric Company, which of course includes our friend Mr. Leach's division here in Oakland, advertise themselves as the "house of courtesy" and this concern is managed by men of well known truth and probity. This claim of theirs will not be denied. But what factor in their whole working corporate body is most conducive to this happy relation between them and their customers? Is it not the correct meter?

MECHANICAL HANDLING OF CARBON BY-PRODUCT OF THE OIL GAS PROCESS.

BY D. J. YOUNG.[1]

The carbon by-product of oil gas manufacture has long been the bug-a-boo of the oil gas engineer. This is a material of undoubted value which, instead of being an asset, has ,on account of the cost of recovery, become almost a liability. Several methods have been devised for handling this carbon, which, on a small scale, were fairly successful, but, when applied on a large scale, they were costly, occupied valuable ground space, and did not give the satisfaction which they should. The large amount of gas which the Los Angeles Gas & Electric Corporation was making, the very high value of land in the neighborhood of our plant, and the fact that the former method was unsatisfactory, forced us to give the matter a most careful study, and now we have a plant which I believe has solved the problem.

Without taking the time to detail the experiments, both successful and unsuccessful, which we have made, I will describe the essential features of our equipment for handling this by-product from the time it leaves the wash-box of the generator until it is in a finished form, and I wish to call particular attention to the fact that at no time need it be handled except mechanically. Portions of this plant are not yet completed, but the first installation has been in regular operation for some time and has demonstrated that the principles involved are correct.

[1]Superintendent of Gas Manufacture, Los Angeles and Electric Corporation.

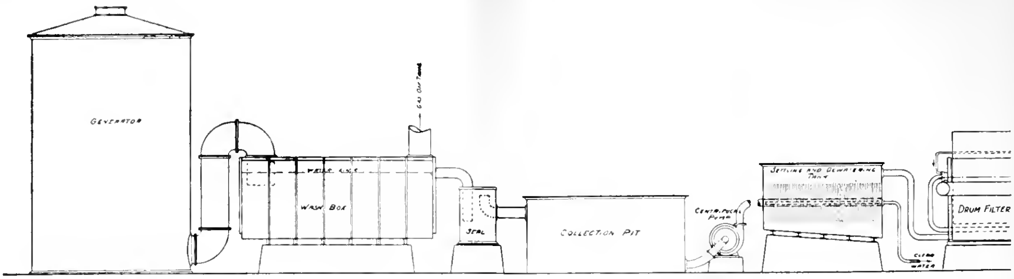


Diagram Showing Mechanical Handling of

From the wash-box the water, which contains the carbon, goes into a seal pot near the operating board of the generator, which seal over-flows through flumes of pipes into a pit, the pit caring for the water from all the generators. The water contains from 1 per cent to 2 per cent carbon. From this pit it is pumped by ordinary centrifugal pumps to our carbon plant, which is located about 2000 feet from the pump house. These centrifugal pumps give excellent service. The water is delivered from these pumps into settling tanks, installed in duplicate to admit of cleaning.

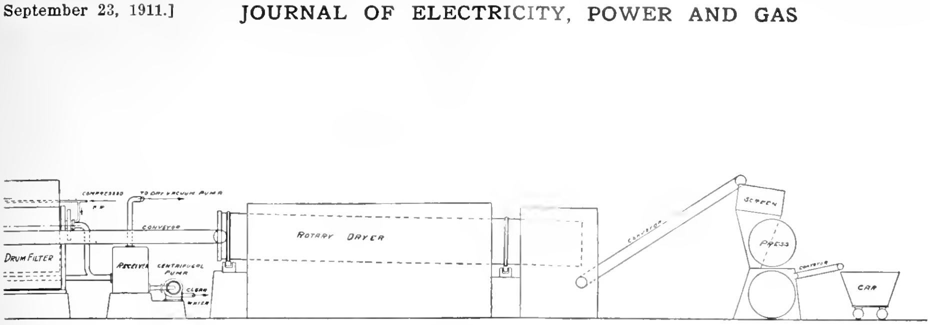
In these settling tanks two operations are performed. First: all heavier particles, such as standpipe carbon, ashes and balls of tar are precipitated to the bottom. Second: a portion of the water is removed.

There are two methods for removing the surplus water. Each is essentially a canvas filter to remove a portion of the water, leaving the balance of the water and the carbon in the tank, with suitable means for keeping the carbon from packing on the canvas and stopping the water from being drawn through. One of these is a leaf filter, similar to those common in the cyanide process, and the other is a pan-cake or disc filter, which is also adapted from the metallurgist. By these methods we remove from 50 per cent to 75 per cent of the water, but sufficient water is left with the carbon so that it is fluid and can be easily handled by the following apparatus. From the settling tanks the carbon is taken into a continuous drum separator. I will describe this piece of apparatus a little more fully, as it is the most important feature of our process.

Briefly this separator may be described as a drum with open ends 11 ft. 6 in. diameter by 16 ft. 0 in. width of face supported on a horizontal axis in a tank, and partially submerged in the liquid or pulp to be filtered. The outer surface of the drum is divided into longitudinal sections and covered with a filtering medium. Vacuum is applied to the sections and as the drum revolves, a cake of carbon forms on the surface. As the sections leave the liquid the cake is dried by the air being drawn through. Just before any one section enters the liquid again, air under low pressure is admitted to this section and the cake of carbon is discharged over a scraper or apron resting on the drum. The cycle is then repeated, the whole operation being continuous and automatic.

The following is a detailed description of the separator: The periphery of the drum is built of redwood staves firmly bolted to cast iron spiders with steel arms, and is made absolutely water tight. The outer surface of the redwood staves is divided into a series of shallow compartments or sections with their dividing partitions running parallel to the shaft. In each section is a grating of grooved wood strips on top of which is fastened galvanized wire screen, which serves as a firm, smooth backing for the filter cloth. This cloth is made in one sheet large enough to cover the whole drum and is stretched tight, being held in place on the ends by rope calked into a groove cast on the ends of the spiders. To protect the filter cloth from wear, to hold it in place and to act as a guide for the scraper, No. 14 galvanized steel wire is wound tightly around the drum, spaced about 3/4 in. pitch. A thin steel scraper which serves to remove the dried carbon, rests on this wire, and is thus kept very close to the filter cloth without touching it.

Each compartment is connected to the vacuum receiver and to the compressor by two sets of pipes which are carried radially to the shaft, and then pass in two concentric circles through the trunnion to the automatic valve. This automatic valve consists of a flat valve plate or seat into which are screwed the vacuum and compressed air pipes leading from the various compartments in two concentric circles of 12 ports each. The valve proper is stationary and consists of a cast iron chamber which is ground to fit the valve seal. In the face of the valve is cut an annular slot or port, which registers with the outer circles of holes. Into this slot is fitted an adjustable bridge, which is long enough to at all times cover one port in the valve seat, in this way cutting off the vacuum from one section of the filter. The valve is held against its seat by atmospheric pressure and is prevented from turning by an adjustable valve stem. A single "blow" port is placed so as to admit compressed air through the inner circle of pipes to the section from which the vacuum has been cut off. By means of this valve, each section in succession is "blown" without affecting the remaining sections, the cake being thus released and the pores of the filter cloth cleansed at each revolution. The air and the water from the sections go to a vacuum receiver which is connected to the wet and dry vacuum pumps. The water is handled by a water sealed centrifugal pump, while the receiver is exhausted by a dry vacuum pump. The water which comes from both this separator and the disc or leaf filter is practically clear and can be used again or discarded, as the needs of the plant call for.



Carbon from Generator to Briquet Storage.

The carbon as delivered by this separator contains from 40 per cent to 50 per cent of moisture, and before being used, it must be further dried. We convey this carbon direct to a rotary dryer, very simiiar to a cement dryer I need not describe this, further than to say that it is a very satisfactory machine, easy of operation and presents no operating difficulties. I would note, however, that we get the best results from this dryer by the use of a pyrometer, the fire end of which is placed in the drying chamber, enabling us to maintain a regular heat and get a uniform product. The carbon is delivered from this dryer containing from 15 per cent to 20 per cent moisture. It is then carried by conveyors to a screen with about ¼ in. mesh, where the lumps are removed and the fine carbon is deposited into a bin. This bin feeds direct into the hopper of a briquet or brick press. This press is similar to an ordinary pressed brick machine, slightly modified for handling carbon. With these presses the carbon is made either into a brick form, for water gas or boiler fuel, or into a briquet for a commercial fuel. The briquets or bricks are carried away from this machine on a belt conveyor and delivered into cars, wherein they are carried to storage yards.

While the bricks or briquets as they leave the machine, are apparently very strong, they are not ready for use until they have been seasoned or air-dried. In air-drying the briquets we pile them from four to six feet deep and leave them from three to six weeks. This should be done under cover. The briquets as we make them are cylindrical in form, 2½ in. in diameter by 2¾ in. high.

There is only one particular feature of the briquet press that should be mentioned, and that is the use of a bronze mold box and dies, in preference to steel. On account of the very great pressure that is employed in the presses, the wear on a steel mold box and dies is very great, and furthermore, the steel rusts, which causes trouble on account of carbon sticking to the molds. With a bronze mold box and dies, there is no rusting, and consequently no sticking of carbon to molds, and the wear is much less.

Attached is a diagrammatic sketch showing each step in the process from the time the carbon is produced in the generator until it is ready to be used or sold.

The cost of handling carbon by this method is largely dependent on local conditions, but I will give of labor necessary. It is obvious that the cost of such items as pumping and conveying is dependent on the approximate capacities of the apparatus and amount distance and height the material must be moved, and under very advantageous conditions, this travel could be almost entirely by gravity.

The separator requires thirty horsepower to operate and the machine can be handled by one man. Its capacity is rated in gallons of water and not tons of carbon, one machine handling about 25,000 gallons per minute, and removing all the carbon therefrom.

We have two dryers, one of forty tons and one of about fifty-five tons per day capacity, figured on material as delivered at about 20 per cent moisture. Each used twenty to thirty horsepower and requires one attendant, using carbon or oil for fuel.

We have two briquet presses, each of four tons per hour capacity. It requires two men and about thirty-five horsepower to operate each. By changing mold box and dies, bricks can be made on these presses. We also have two brick presses, one of two tons and one of one ton per hour capacity. The storage of briquets and bricks is simply a question of location and can be arranged to be handled very cheaply.

While at present we use carbon for boiler fuel and water gas fuel, and manufacture briquets for sale as commercial fuel, our experience has proven that briquets for commercial fuel yield the greatest value per ton for the carbon, and therefore receive first consideration in our plant.

As to the market for briquets, this is also a local condition, but with the prevailing prices for coal on the Pacific Coast, the market should be easily established, especially in view of the admitted superiority of briquets over any other solid fuel.

The following is an average analysis of the briquets as delivered to our consumers:

Moisture	3.94%	
Volatile and combustible matter	11.41	
Fixed carbon	83.94	
Sulphur	.51	
Ash	.20	100%
British Thermal Units per pound	14,540	

Tests on carbon briquets, made according to United States Government specifications, for breakage, shows results which are very favorable compared with either coal or other forms of briquets.

RATES FOR GAS SERVICE.

BY C. L. CORY.

In all probability more money has been expended in the various States and cities of the Pacific Coast during the past decade, either directly or indirectly, in connection with litigation or other phases in determining the rates for gas service, than has been the cost, in the same territory, of all experimental and other related scientific and engineering work of improving the methods and reducing the cost of the manufacture, distribution and sale of gas. Certainly, there is no problem connected with the gas industries more important than that of rates. There is a spending and receiving side to every organization. It is the difference between what is spent to provide a commodity and the amount for which the commodity in the aggregate is sold which establishes the desirability of the business. Unlimited commendation is due the gas engineers of the Pacific Coast for the work they have done in recent years to improve the processes of gas manufacture, including all of the notable advances in high pressure distribution and improvement of service, as well as the increased economies and reduced cost of production. It is but natural, therefore, that we should be equally interested in the consumption and use and especially the proper rates to be charged for gas, not only from the standpoint of the manufacturing companies, but quite as much must the consumer's position in the matter be given due consideration.

*The term "public utility" has been defined as meaning and embracing each corporation, company, firm, individual and association, such as express, telephone, telegraph, sleeping car, freight-line, equipment, electric light, gas, natural gas, pipe line, waterworks, messenger, signal, union depot, water transportation, heating and cooling companies; street, steam, suburban and interurban railroad companies; also any plant or property owned or operated by such companies, corporations, firms, individuals or associations.

It is such companies as above indicated that provide service to the public, and the rates for such service should be based primarily upon the cost of providing adequate and satisfactory service. To determine this cost is many times a difficult task, and especially so when the devices and system required to provide the service are not fully developed and standardized. As an illustration, the rates for freight and passenger service between San Francisco and Los Angeles, whether by steamer or by rail, have been established for such a length of time that it is not a difficult matter to decide upon the reasonableness of such rates, and, therefore, rates may be established that are more or less permanent and not subject to material revision from year to year. However, to determine adequate freight and passenger rates between these cities using the automobile or the aeroplane would be exceedingly difficult, if not impossible. However, it is not to be concluded that in future years, service, both passenger and freight, with the newest aerial devices for transportation may not become so well established, reliable and satisfactory that rates of service might not be readily determined.

The business of manufacturing and supplying gas has been very thoroughly standardized, although progress is constantly being made in the methods of manufacture as well as the increased economies in distribution. High pressure systems have been introduced in recent years. The methods of gas manufacture from California crude oil on the Pacific Coast have been perfected within a comparatively recent date. As compared with many other public utility enterprises, however, the gas business has been established so long that the determination of the cost of service is comparatively easy.

The cost of delivering gas to the consumer necessarily embraces the determination among other things of a fair valuation of the plant that is devoted to public use, the gross earnings under any given set of rates and the reasonable operating expenses when depreciation of the physical property and adequate returns on the investment are included.

The general information necessary in order to arrive at the proper rate for gas service may, in general, be subdivided as follows:

1st. The valuation or appraisal of the plant used for the manufacture and distribution of gas.

2d. The annual cost of operation, including a complete segregation of all accounts set forth in such a manner as to indicate the different operating costs per 1000 cubic feet of gas manufactured and sold.

3d. A statement of the quantity of gas made and sold for a number of years, preferably not less than five, and the total revenues received each year from the sale of gas.

Valuation.

There are a number of fundamental principles involved in obtaining the valuation of a gas plant and system to be used in determining a proper rate for gas service. It is quite as important that corporations themselves should determine for each year the valuation of the system upon which a return on the investment is to be earned as it is for this valuation to be determined by any public body, whether only incidentally or directly concerned, with the fixing of rates.

The original cost of construction, the cost of reconstruction or reproduction new, the cost of reproduction new less depreciation, the present value, the assets and liabilities taken as a whole, the capitalization, the bonds and stock outstanding, and the gross earnings and operating expenses are all elements that should be considered in determining the valuation of a public utility for rate fixing or other purposes. Each of these elements constitutes evidence of what is a fair value. The original cost, the cost of reproduction new and the present value bear a very close relation to the physical property of the plant and are, therefore, most usually considered of the greatest importance in determining the proper valuation. Which of these three elements gives the best indication of the value will vary in each individual case.

The original cost can, if all records of construction are available, be usually determined by what is known as the historical method. The conditions

*Laws of Ohio, Langdon Act, 1910, Page 429.

under which the construction of the system was carried out, whether all done at once or extended from year to year as the growth of the business required, will be covered in this method of determining the original cost. When proper charges only are included and no mistakes have been made, for which the builders may be properly held responsible, the original cost represents the investment that has actually been made in the physical property of the plant.

The rapid growth of many systems, however, and the rapidity with which changes have been made, coupled with inadequate records, make it many times practically impossible to determine the original cost with any degree of reliability. Much depends upon the manner in which accounts and records have been kept. In order to be of value they should show the actual cost of the different parts of the plant, segregating labor and material, the cost of engineering superintendence, management, and administration, the amount that has been allowed as interest on the capital during the construction period, the cost of financing, which will include the discount at which bonds were sold, the basis upon which stock has been issued or sold, all promotion expenses and similar items. It is not difficult to imagine records which would give the above information, but I venture to say that most rare is it that the original cost of a gas plant operating at the present time may be obtained entirely in such a complete and satisfactory manner.

Moreover, the original cost even when determined in full detail may not be the valuation upon which reasonable returns should be allowed. It is a question of equity between owners of the plant on one hand and the customers on the other. The owners are entitled to a reasonable return upon what they have invested, while the customers should not pay rates for service that will yield more than an adequate return upon the investment necessary to supply such service. If the plant has been built when prices were abnormally high and money has been lost through lack of reasonable skill, excessive promotion fees and discounts, private understandings between the builders of the plant and the contractors, the original cost may be decidedly greater than the valuation on which the investors should be allowed to earn.

Conversely, it may be that the plant was constructed when the prices for labor and material were excessively low, or a great portion of the plant may have been obtained through failure of previous owners to successfully carry on the business, due either to temporary financial difficulties or what has been more common, great strides in the method of manufacture, resulting ultimately in foreclosure. In such a case the original cost would hardly be a fair figure upon which to base the valuation for rate fixing purposes, as the foresight and enterprise of the present owners certainly justifies some regard.

The original cost is so rarely available that the cost of reproduction new of the plant usually must be determined. A great deal of engineering knowledge and detail work is necessary to obtain this result. Invariably, a complete inventory of the physical property is the first step required. The only satisfactory inventory is one obtained as a result of actual inspection and enumeration, aided, as much as possible, by all the records available, and supplemented by such additional information as may be had from the various heads of departments and other employees of the company. Such an inventory should include for each different part of the property the amount of labor and material required to provide ready for operation each element of the completed plant. The next step consists in obtaining from all data obtainable a suitable price per unit, not only of each element of the property, but the labor and material required to install the devices in position ready for operation. It is well in determining such unit prices to take a period covering at least five years and obtain the average in this manner. The total and average cost of the labor and material that has entered into the plant ready for operation is thus obtained.

Inventories.

Inventories of the actual physical property which taken together go to make up a modern gas plant and system should include the following:

Real estate.	Furniture and fixtures.
Buildings.	Automobiles, motorcycles, etc
Gas works, including holders.	Stable equipment.
Street mains.	Tools.
Services	Supplies.
Meters, regulators and lamps.	Working capital.

Real Estate.

A complete list of all real estate used wholly or in part for the purpose of the manufacture and the supplying of gas should be included in the inventory. The values placed upon this real estate should be determined in so far as possible by actual sales of property in the vicinity of the real estate in question when used for a similar purpose. The purpose for which the property is used must always be taken into consideration. Disinterested real estate men are usually able to give information leading to a rational decision in such matters. Unfortunately, assessments for taxation purposes are not of material assistance in appraising such real estate. On the other hand the actual figures at which adjacent property is sold are rarely available.

When a gas company has real estate not actually in use but is holding it for future occupancy the question naturally arises should such real estate be included in arriving at the valuation of the plant for the purpose of determining the proper rate for the sale of gas at any given time.

In arriving at a conclusion in this matter, it is best to proceed upon the principle that it is proper to include all property actually required and used in the carrying on of the business at the time in question and not to include such real estate not required or used on the date the valuation is made. However, at some later period when the real estate is actually put to use and occupied by buildings and equipment, that are a part of the operating system, in arriving at the valuation, there should be added interest and taxes during such time as the investment in such lands has been tied up but not productive. On any other principle, customers of today would pay a rate for serv-

ice in excess of what they should and customers of the future may pay relatively less and thereby benefit unduly.

Buildings.

All of the buildings owned by the company as a part of its operating system should be included in the inventory and so segregated that it will be possible to separate the structures such as office buildings, etc., from the structures required as a part of the manufacturing plant. This should be done in order to obtain the cost of the manufacture of gas as delivered to the holders separate from the general expenses connected with the operating of the property usually connected with the expense of the general offices of the company. The inventory costs of all buildings are usually best obtained from the plans, specifications and contracts or other records of the company. The condition of the buildings in general usefulness and probable future life should be taken into consideration in determining the probable value based upon original cost, cost of reproduction new and present value.

Gas Works.

The gas works inventory must include besides buildings all of the equipment necessary in the manufacture, metering and storing of gas, such as boilers, blowers, compressors, generators, exhausters, holders, heaters, pumps, piping, purifiers, scrubbers, and miscellaneous equipment. The date of purchase or contract and the date when installation was commenced and completed as well as the type of apparatus and by whom manufactured, should be included as a part of the inventory. When possible, the cost of each element of the entire manufacturing plant ready for operation segregating labor and material is desirable.

Street Mains.

An inventory of street mains is best obtained by tabulating and mapping from work reports all installations and removals for as long a period as records are available. Scaling street mains from maps in order to obtain the aggregate length of the various sizes should only be resorted to when the actual records of installation are not available. The size of all street mains including fittings and accessories of every character and classified as to the material used, such as wrought iron, cast iron or casing, should be included in the inventory. In a similar manner the cost of replacing the street surface in the various kinds of paving should be determined from the most recent records available for such work.

The item of paving in determining the value of underground street mains and services has been variously considered. Every legitimate expenditure in adapting the utility to the progress and community growth, even if this involves the removal of the plant from one locality of the city to a distant and more remote location, is a proper charge to construction. All expenditures for putting down pavement by the company as required by the city or the cost of cutting through such pavement for extensions and construction purposes, and its replacement, are unquestionably proper capital charges. However, it is a question whether a gas company may properly capitalize the expense of municipal betterment which it has not borne and when such benefits to the gas company are only incidental and can only exist from the standpoint of the cost of actually reproducing their underground system, after the street has been paved, when as a matter of fact the existing underground mains and services were laid before the paving was actually put down. The cost of such paving is not a proper element of value when the cost of laying such pavement has not been paid for by the gas company nor any expense incurred therewith, providing of course that all costs borne by the company of changing the grade or depth of underground mains and services, in order to adapt them to conditions required for paving by the city, are included in the capital account.

Services.

In obtaining the inventory of services, it is most satisfactory to list all services, obtaining thereby the size, length, and character of each service as shown by the records of this department. Only that portion of the service belonging to the company should be included and if consumers have paid for any portion of the service that portion should be considered as belonging to the company. The total value of the services should represent only those actually owned by the company and in general should not include any services or reproduction of any services within customers' premises unless the cost of the same has actually been met by the company.

In order to arrive at a unit cost of services, it is best to obtain the actual labor and material charge for a number of services installed in various parts of the district served and at different seasons of the year, to get a reliable average cost per unit length of service.

Meters, Regulators, Etc.

The inventory of meters in service is usually readily obtained from the company's records. The inventory cost of the meters should include the necessary testing, painting and all storeroom expense. The cost of installing the meters should include all costs from the time the order leaves the general office until the order and record of installation are returned to the general office. The time cards of meter installers covering a considerable period can with great advantage be used to determine the cost of installing meters of different sizes.

Furniture and Fixtures, Automobiles and Motorcycles, Stable Equipment, Tools and Supplies.

Complete inventories should be made of the property owned and in actual use by the company for the carrying on of the business covering all subsidiary items such as furniture and fixtures, automobiles and motorcycles, stable equipment, tools and supplies. Only those supplies should be included which are active and of the normal quantity carried in stock and necessary for the operation of the company's business.

(to be continued)

THROOP POLYTECHNIC INSTITUTE, PASADENA, CALIFORNIA.

Throop Polytechnic Institute will begin its next academic year on the 20th of September, when the offices will be open for entrance examinations. Registration will take place September 23 and 25, regular instruction beginning on the 26th. The enrollment will show a substantial increase over that of last session. Throop authorities are especially pleased with the character of most of the applications, which show an unusually good standing in the high schools from which applicants come, as certified by the respective principals. Of the high schools of Southern California, Los Angeles, San Diego, Monrovia, Santa Ana, Compton, Redondo, Banning, Occidental and Throop Academies, and the Pasadena High School, will be represented. Among the Pasadena Freshmen may be named Joe Beek, Raymond Call, Ayre Powell, Verne D. Elliott, Earle A. Burt and Robert S. Ferguson.

Throop Institute Building—Pasadena.

The budget for the approaching year shows an investment of several thousand dollars for new equipment, in addition to the large and valuable apparatus installed. The Institute easily leads the West in the character of its equipment in Electrical and Mechanical Engineering, while the Civil Department will be materially advanced as applications increase for that course. Friends of Throop continue to prove their devotion by generous deeds, the most recent benefaction being a gift of $25,000 made last week by a resident of Los Angeles. There are two residents of that city on the Board of Trustees, General M. H. Sherman and Dr. Norman Bridge, President. The Pasadena members of the Board in the order of seniority of service, are Dr. Everett L. Conger, Mrs. Robert J. Burdette, Hiram V. Wadsworth, Dr. James H. McBride, Messrs, Hazard Halsted and Arthur Fleming, Judge Charles J. Willett, Dr. George E. Hale, with Messrs. Charles V. Gates, James Culbertson, Henry M. Robinson, William M. Vedder, and John Wadsworth.

There will be several changes in the Faculty for the coming year. Dean George A. Damon will begin his active duties as supervisor of Electrical, Mechanical and Civil Engineering, while keeping in lively touch with the practical affairs through his management of the Bion J. Arnold Company in Los Angeles, which is at present engaged in the study of the transportation problems of that city. Professor W. K. Gaylord, who is spending a year at Berkeley, will be succeeded in the Chemical Department by Dr. William R. Flint, recently of Yale. Professor B. F. Stacey, of the department of History and Economics, will, by order of his physician, take a year off, his place being filled by Professor Charles E. Barber, formerly Associate Principal of Throop Academy and head of the equivalent department in that institution. The complete teaching staff will be as follows:

George A. Damon (B. S., in E. E., University of Michigan), Dean; Supervisor of Electrical, Mechanical and Civil Engineering.

Royal W. Sorensen (B. S. in E. E., University of Colorado), Professor of Electrical Engineering.

Lucien H. Gilmore (A. B., Stanford University), Professor of Physics.

Herbert B. Perkins (S. B., Massachusetts Institute of Technology), Civil Engineering and Mathematics.

Robert E. Ford (E. E., University of Minnesota), Mechanics and Hydraulics.

Charles H. Kicklighter (B. S. in M. E., Georgia School of Technology), Mechanical Engineering.

Frederick E. Beckman (Ph. D., University of Chicago), French, German and Spanish.

William R. Flint (Ph. D., Yale), Chemistry.

H. C. Van Buskirk (Ph. D., Cornell), Mathematics.

Charles E. Barber (A. M., University of Nebraska), History and Economics.

Clinton K. Judy (B. A., University of Oxford), English.

Arrangements have been made with the city management of the Polytechnic High School (formerly Throop Academy), by which instruction will be given there on Saturdays to Freshmen who have not had the advantage of polytechnic high school training before entrance, and the elementary shop work of the Institute will also be done in the same way, its own laboratories being reserved for the higher branches.

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Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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CONTENTS

Helping one Another

It is typical of the struggle of life that when we have encountered obstacles on the road to success we want to make the pathway easier for the younger brother tediously treading after us. No higher make-up of the true man can exist than that of possessing an inner desire to help his younger brothers get a proper start in the work of life.

It was an inspiring sight when on last Tuesday morning the members of the Pacific Coast Gas Association raised in a few minutes over six thousand dollars as a donation to the University of California to assist in the starting of technical instruction looking toward a degree in gas engineering at the State institution. John A. Britton sprung the idea upon the convention and pledges began to roll in from all sides and, although but five thousand dollars were asked, over six thousand were pledged in less than fifteen minutes. The spirit back of the pledges was the inspiration to those who beheld it. The big corporations gladly gave their bountiful portion, while the young men of simple means spoke of their financial inability to pledge heavily, but said that they wanted to make the path easier than they had found it, and consequently wanted to pledge their portion, no matter how insignificant it might seem. Such acts of a great organization evidence its anxiety to properly prepare young engineers to solve the future problems of gas engineering on the Coast.

And all of this leads to comment on the general fraternal spirit of gas men on the Coast. No one can be present at their gatherings for but a few minutes without being impressed with that inexpressible something which pervades their meetings—that something which draws men closer together and forges a lasting bond of fellowship. How clear and true and earnest are their gatherings!

Beginning with the able address of President Leach, followed by the scholarly paper of E. C. Jones, on down the line, including the brilliant appraisement paper of C. L. Cory, and so on through the list of papers. All were intensely interesting and well-discussed. The striking feature of all was the deep-felt interest in the welfare of the convention by such men as L. P. Lowe, John Martin, and that father of all that is noble and good in our western life, John A. Britton.

It does one good to attend such gatherings. If anyone has a grouch or an inner pent-up feeling of a something that doesn't belong in his inner physical make-up, it certainly fades away at such a getting together as the Oakland convention of last week. All honor to those having the convention in charge.

Throop Polytechnic Institute

Elsewhere in these columns will be found an account of the fall opening of Throop Polytechnic Institute. The Journal has watched with intense interest the trend of affairs in Pasadena looking to the betterment of affairs technical. The high ideals set forth in the announcement of courses cannot but have a deep and far-reaching effect

in raising the standard of scientific and technical study on the coast.

With such broad-minded citizens to direct its destinies as Dr. Norman Bridge, Mrs. Robert Burdette, George E. Hale, and a dozen others, a brilliant future is without question. With such well-known engineers as George A. Damon and Ezra F. Scattergood, it would be difficult for the western youth to find better opportunities of absorbing engineering knowledge.

At first sight, the decreased enrollment due to the high standards decided upon, a small enrollment of thirty students, would seem to handicap affairs. Ah—but how different in reality, so far as opportunities presented the student to have personal contact with his instructor. Under this regime, the western idea of a friend as being a "person who knows all about you and likes you," is most strongly realized.

Situated in heart of a country of boundless energy—in the heart of a country that dreams dreams and makes good—it offers every inspiration for the shaping of future ideals. The nearness of the San Gabriel mountains offers unexcelled opportunities for hydro-electric study. It is to be hoped that some philanthropist may endow the Institute with sufficient funds to install a high pressure hydro-electric plant, and thus make Throop unique among the technical institutions of the world and symbolize its very existence as being in the greatest hydro-electric country in the world.

The Journal has every good wish for Throop and her struggle ahead. May she prosper, and above all may she ever cling to her high ideals!

A City's Traffic Struggle

Two issues back, the Journal commented editorially on the appointment of a traffic expert by the city of San Francisco to look into the problems pertaining to simplification of traffic in the great western metropolis. At that time we congratulated the authorities upon the securing of such an able engineer as Bion J. Arnold, past president of the American Institute of Electrical Engineers and one of America's most distinguished traffic experts.

We sincerely hope that Mr. Arnold will wade into the task ahead of him without fear, and that his recommendations will receive immediate approval and quick action on the part of the authorities having the matter in hand. In the mornings from eight to ten or in the afternoons from four-thirty to five-thirty, by the civilian, who tediously but safely threads his way across the overcrowded central districts of San Francisco, a just cause for the return of thanks to his Maker is deeply felt for his safe deliverance. The growth of the traffic difficulty during the past few months is almost appalling. While this traffic difficulty suggests congratulations upon San Francisco's business growth, it is evident that the confusion must be remedied at once or the welcome traffic will become paralyzed. It is almost pitiful to observe the commuter hasten to catch the departing ferry after completing the business tasks of the day. He hastens down market street observing ahead on the great ferry clock, but scant time to make connections. Wearily he dodges the automobiles flanking the great thoroughfares opening into Market street. Having arrived breathless at the big merry turn of car tracks in front of the ferry building, like the recent mermaids who swam the golden gate channel, he plunges in and amid the roar and din of cars, he looks around to catch his bearings, but—alas—there is no life-boat nearby to help him in case he falters. He must plough ahead. In the labyrinth of tracks encountered he might playfully imagine he is once more threading the maze at Del Monte, were a false step not so fatal. He makes one deep gasp for breath; then, with a supreme effort he comes in front of the ferry building only to have his nerves rent to pieces by the howling mob of newsboys peddling their daily mess of frightful accidents due to traffic congestion in our great cities. Finally, physically worn out, the ordeal of riding across the bay on an overcrowded, ill-ventilated boat, thence, by rail to his suburban residence is over, and no wonder his loving wife greets him with the remarks: "Why, John, you look so tired; you must'nt work so hard."

In January, 1910, Mr. Arnold made an extensive report on the traffic conditions of the city of Pittsburg. In the analyzing of the traffic conditions there, he compiled statistics covering fourteen of America's foremost cities. Among the data detailed were tabulations of passengers per car mile and annual earnings per car, and in both instances San Francisco's street railway systems outranked every other American city. Such figures of course should not be taken too seriously without going into every detail in their makeup. They do, however, indicate a healthy, prosperous condition of her great traffic companies.

While unquestionably the great traffic companies can greatly improve their present methods and thus clarify the congestion, the city of San Francisco, no longer an overgrown country town, should prepare to carry a large portion of the commerce of the world. Carefully selected expert officers should be detailed to direct the traffic at the congested centers as is done in Chicago, and more especially in Detroit. An overhead crossing at the Ferry is an immediate need, and the day for the elevated and perhaps the underground road to relieve and segregate the local from the suburban traffic is now at hand.

With a city and tributary population of nearly a million, new conditions are before the bay cities for their earnest and most careful consideration. Never before did a get-together policy mean so much as it will mean now. The recent announcement of the great Atlantic ocean-going companies that immediately upon the completion of the Panama canal, through service will be established from European ports via the canal to San Francisco, can mean nothing but an enormous influx of population. San Francisco—the bravest peopled city of the world—surely she'll be equal to the crisis!!

PERSONALS.

Henry F. Frosch is reported seriously ill at the German Hospital, San Francisco.

A. C. Paulsmeier, chief designer of the Byron Jackson Machine Works, has just returned to San Francisco from the East.

A. G. Wishon, general manager of the San Joaquin Light & Power Corporation, arrived at San Francisco last week from Fresno.

Melville Dozier, Jr., assistant manager of the Northern Electric Railway Company, was a recent arrival at San Francisco from Sacramento.

F. O. Sievers, of the sales corps of the Fort Wayne Electric Works, returned to San Francisco during the past week from a Southern California trip.

H. W. Crozier, of Sanderson & Porter's Pacific Coast branch office, has returned to San Francisco after a trip through the interior of California.

R. S. Buck, of the firm of Sanderson & Porter, who recently spent some time in Idaho investigating an irrigation project, has returned to New York.

B. T. Holtz, manager Northern Electric Company, Vancouver, is to be married September 26th at San Francisco. The Journal extends hearty congratulations.

T. C. Martin, executive secretary of the National Electric Light Association, was in attendance at the Spokane convention of the N. W. Electric Light and Power Association.

E. F. Scattergood of Los Angeles is examining various power equipments throughout the Northwest as suggestions for the electrical features of the Los Angeles aqueduct.

Messrs. Stafford, W. V. Cullen and John Alberts have joined the sales force of the Allis-Chalmers Company's San Francisco office under Fred L. Webster, the Pacific Coast manager.

A. B. Saurman, manager of the Pacific Coast branch of the Standard Underground Cable Company, is expected to return to San Francisco about October 1, after spending a month in the East.

H. G. Aylsworth, manager of the Aylsworth Agencies, has returned to San Francisco after spending the past week at Los Angeles, where his firm has just opened an office under the management of W. R. Greene.

William Taylor, sales manager of the General Roofing Company, with headquarters at San Francisco, is now on one of his regular trips to the Northwest, and was in Tacoma recently looking after the interests of his company there.

A. W. Ballard, who is an officer of the Phoenix Gas & Electric Company of Phoenix, Ariz., and was at one time manager of the General Electric Company's Los Angeles office, recently motored up from Los Angeles to San Francisco.

W. W. Briggs, assistant sales manager of the Westinghouse Electric & Manufacturing Company, has returned to his San Francisco office after accompanying Sales Manager S. L. Nicholson as far as Los Angeles on his way to East Pittsburg.

Harris J. Ryan, professor of electrical engineering at Stanford University, California, is at Colorado Springs, Colo., in connection with his work for the Los Angeles aqueduct, for which he has been granted a year's leave of absence from his college work.

R. D. Holabird, of the Holabird-Reynolds Company, left last Tuesday for Seattle, where he has a branch electric supply house. He took with him as far as Portland the silver cup which he has won three times as a golf trophy and which is to be contested for again.

Frank R. Bates, of the engineering firm of Bates & Clark, Seattle, left for his old home at Eau Claire, Wisconsin, recently, accompanied by Mrs. Bates and the family. Mr. Bates has been extensively engaged in engineering work in the neighborhood of Baker, Washington, and now takes a well earned vacation.

J. H. Wallace, chief engineer of the Tidewater & Southern Railway, recently visited Turlock, where track laying has just been commenced on the 80-mile standard gauge electric road, which is to be built via Modesto to Stockton. Construction work will be pushed from both ends of the line.

Henry J. Pierce of Spokane, Wash., who is interested in local and suburban electric railways at Amsterdam, Holland, and was for some years head of the Buffalo Street Railways, spent the past week at San Francisco on business. He is promoting a one hundred million-dollar merger of the numerous export lumber mills of Oregon and Washington.

Thomas M. Moore, the mechanical engineer who had charge of the machinery and power divisions of the expositions at St. Louis and Buffalo, arrived at San Francisco during the past week. He has been selected by the directors of the Panama-Pacific International Exposition Company to consult with them concerning power problems in connection with the coming World's Fair.

J. D. Douglas, manager of a suburban railway line extending out of Auckland, New Zealand, recently arrived at San Francisco by steamer. He is figuring on electrizing the system and will inspect electric roads in this country. He will possibly make extensive purchases of electrical equipment. While the car bodies could be built in New Zealand, the electrical machinery would be imported.

J. G. Henninger, the illuminating engineer of the National Electric Lamp Association, will deliver a lecture before the "Electrical Vehicle Association of America" which holds its annual convention in New York City, October 10th. His paper will cover the illumination of public and private garages, and also touch on the lighting of automobile sales rooms. As there is little information on such matters, Mr. Henninger's lecture will no doubt prove of much interest and value to automobile men, who desire to secure the best illumination possible for their particular use.

ELECTRICAL CONTRACTORS' NOTES.

The McFell Electric Company have been awarded the contract for installing a lighting system at Fort Miley for the sum of $17,200. This bid is $700 above the lowest bid, but the Government engineers figure that it is the best bid, as the McFell Company agrees to install the work in 120 days, against 180 days, which the lowest bidder wanted. This company has an office in Chicago, as well as San Francisco, and have done some very large work in this city. Among their jobs are the Merchants' Exchange, Royal Insurance Building, the Y. M. C. A. Building and the Bohemian Club. The San Francisco office is in charge of Frank Watts, who is considered by the contractors as one of the leading men in the contractor's business.

The Native Sons' Hall has been let to the Standard Electric Company for the sum of $6000.

Decker Electric Company have been awarded the contract for the Terminal Hotel.

Among the jobs that are ready for figures at present are the Standard Oil Building, Regents Hotel, Downtown Realty Theater and Hotel.

PACIFIC COAST BRANCH OF IDEAL ELECTRIC AND MANUFACTURING COMPANY OF MANSFIELD, OHIO.

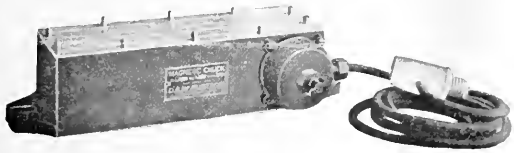
S. Glen Vinson, secretary and general manager of the Ideal Electric and Manufacturing Company, Mansfield, Ohio, has been in San Francisco the past week for the purpose of establishing a branch house on the Coast. R. B. Elder has been appointed sales manager.

It speaks well for the company who, in the past three years, has increased its business to that extent that they are obliged to maintain their own establishment and carry a large stock of goods on the Coast to care for their trade.

INDUSTRIAL

MAGNETIC CHUCKS.

As a labor saver there is probably no form of electrical device that will prove of greater benefit in the machine shop than the magnetic chuck. It possesses a very wide range of usefulness in holding pieces on the grinder, shaper and milling machine and where a large number of pieces are to be machined, it will frequently be found that the labor saved by the use of such a device as compared with old methods of clamping or bolting will pay the entire first cost of the chuck within the first week or ten days of service.



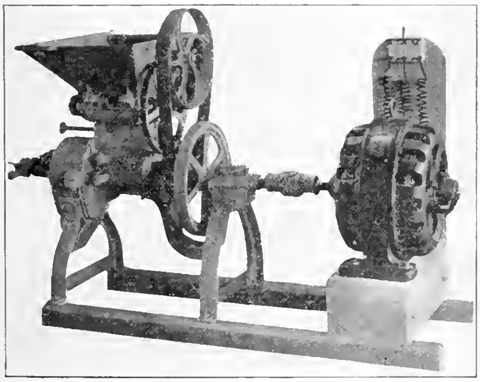
Magnetic Chuck.

In the magnetic chucks which are being placed upon the market by the D. & W. Fuse Company of Providence, R. I., the difficulties which were prevalent in the early chucks designed have been eliminated. Trouble was formerly experienced due to the burning out of the magnet coils, where the chuck was put into prolonged service. In the D & W chucks the magnet coils are practically indestructible by overheating as they are wound with Delabeston Wire, or special heat-proof insulation of pure asbestos, which we manufacture and which can safely withstand continuous temperatures as high as 400 degrees Fahr. without destruction. Furthermore, the coils are so designed that should they accidentally become injured, they can be readily removed by the workman and a new coil inserted at slight expense.

The chucks are both oil and waterproof and are equipped with a demagnetizing switch for readily releasing the work.

MOTOR DRIVEN GRAIN MILL.

Electricity is becoming more and more of a factor on the farm, and especially those farms which can easily procure central station power. The accompanying illustration of an



An Improved Type of Motor-Driven Grain Mill.

electrically driven No. 2 Kelly Duplex Mill is an excellent and popular example of the advantages of electric drive and another factor in building up the day load.

The mill is the product of the Duplex Mill and Manufacturing Company of Springfield, Ohio, and is a great favorite with feed dealers, farmers and stock feeders. It will grind any kind of grain, cotton seed, corn cobs, and shucks, and produce a grist of any desired quality, coarse, medium or fine.

The grinding surface is just double that of the ordinary mill, owing to a double set of grinders or burrs, for which reason it is called the Duplex. A device is provided to permit regulating the feeding of small grain from the base hopper into the crushers. This prevents the grain from clogging in the hopper and causes an even and ready flow. The application of electric drive insures a maximum capacity for grinding with the least operating expense and affords an efficient and reliable source of power at all times.

This mill is driven by a 7½ H. P. alternating current induction motor manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa.

TRADE NOTES.

The Pelton Water Wheel Company has closed a contract with the Montesano Light & Water Company for a Pelton-Francis turbine, direct connected to Westinghouse generator, which will be used to increase the capacity of the system at Montesano, Wash.

The Crocker-Wheeler Company, Ampere, N. J., announces the resignation of Mr. Gano Dunn who for a great many years has filled the position of chief engineer and first vice-president in the Crocker-Wheeler Company with conspicuous ability, and he leaves with the very best wishes of the company and his many friends and associates in it, for his future success.

The General Electric Company has sold to the Siskiyou Electric Power & Light Company two 500 kw. water-cooled transformers of 34,600-v.—60,000-v Y primary, 10,000 v. secondary; three 300 kw. water-cooled and two 300 kw. oil-cooled transformers, of 34,600-v.—60,000-v Y primary, 2,300-v. secondary. Also three sets of aluminum cell lightning arresters for outdoor use and one set for indoor use.

F. C. Foster, manager of the Pittsburg office of The Buckeye Electric Company, seems ambitious to become the aviator of the electrical industry. At the convention of the Pennsylvania Section of the National Electric Association Mr. Foster made a balloon ascension at Lake Conneaut which should entitle him to recognition by the Aero Club. The balloon reached an altitude of sixty-four hundred feet and covered a distance of over thirty miles before landing near Meadville, Pennsylvania.

BOOK REVIEW.

McGraw Electric Railway Manual. Successor to American Street Railway Investments. Edition of 1911. By Frederic Nicholas. Size 9x13 inches; 430 pages. Transportation maps for all large American cities; clear type; strong paper; durable binding. Published by McGraw Publishing Co., and for sale by Technical Book Shop, 604 Mission St., San Francisco. Price $7.50.

A complete summary of this interesting and valuable book appeared in the reading columns of the Journal of September 16. The book is so full of items relative to American railway practice, it is difficult to describe it in brief. Tabulations of earnings, expenses, balance sheets, statistics of operation, track and equipment, together with the names and addresses of officers and directors of the electric railway companies of America, make the book absolutely indispensable to all those who desire quick and accurate information.

NEWS NOTES

FINANCIAL.

NOGALES, ARIZ.—The bonds for a water system and also those for a sewer system have been carried by a large majority.

ASOTIN, WASH.—The taxpayers of Asotin have voted to bond the town for $35,000, to provide funds for the installation of a modern water system.

LONG BEACH, CAL.—The $850,000 bonds authorized at the recent special election to pay for the purchase of the Long Beach and Alamitos Water Companies were sold to these two companies by the council at par and accrued interest.

CALISTOGA, CAL.—A deal of considerable importance to Calistoga and the upper Napa Valley was consummated when William Spiers sold his electric light business to the Napa Valley Electric Co., whose principal place of business at present is St. Helena.

BRIGHAM CITY, UTAH.—The election held at Honeyville went in favor of bonding the municipality in the sum of $12,000 for waterworks and electric light and power purposes. It is estimated that $7000 will install the waterworks, while the balance of $5000 will install electric lights.

YREKA, CAL.—The Siskiyou Electric Power & Light Co. has purchased the electric power and light plants of the Rogue River Electric Company and of the Prospect Construction Company, including several hundred miles of high tension wire in Southern Oregon. When the construction work now in progress is completed, a total of 80,000 h.p. at low water will be developed with a reservoir storage which will contain a peak load storage capacity of 60,000 h.p.

AUBURN, CAL.—The Pacific Gas & Electric Company will expend $10,000,000 in extending its power system. The additional hydroelectric capacity of the company's system will include a tower line from a power plant on Bear River, Placer County, to the Bay centers. The power plant is to be erected on property that was formerly owned by the South Yuba Water Company's system. The system was absorbed by the Pacific Gas & Electric Company the first of the present year. The Pacific Gas & Electric Company now has a total capacity, in eleven installed plants, of over 90,000 h.p. and in steam plants of over 50,000 h.p. The plans, in the proposed extension, will give an additional 71,000 h.p. Plans in the proposed extension also include the extension of a dam in the canyon of the South Yuba River, below Lake Spaulding, which will increase the present existing power storage, which is obtained from 15 lakes in Placer and Nevada counties, by 2,500,000 cubic feet. From this storage reservoir the water will be conveyed through tunnels and ditches to Bear River. The first plant will have a head of 1647 feet, developing 50,000 h.p. and the second plant will have a fall of 750 feet, with a capacity of 21,000 h.p. Active work is now going on at the dam site below Lake Spaulding. Surveys have been commenced for all the tunnels and canals necessary. Rights of way are being obtained for a tower line to tie in with the present system of the company, which covers the entire portions of Central California and aggregates, in high tension lines alone 1100 miles.

ILLUMINATION.

ELLENSBURG, WASH.—Bonds in the sum of $110,000 have been passed at an election for improvement of the municipal lighting plant.

MORTON, WASH.—The commissioners have granted a franchise to A. W. Van Arsdale for the installation of a water and light system at this place

TACOMA, WASH.—Petitions have been received for the installation of street lights on certain avenues.

NORTH YAKIMA, WASH.—The Pacific Power & Light Company has received a cluster lighting power contract at this place.

VICTORIA, B. C.—The special council commission has awarded the contract to Hutchinson Bros. at $5827 for the installation of cluster lights on Fort street.

SAN BERNARDINO, CAL.—The City Council has passed an ordinance granting to Fred B. Mechling a franchise for an electric system for transmitting electricity for light, heat and power.

McMINNVILLE, ORE.—This place will install a cluster lighting system on the principal streets. Ornamental poles with three lights will be placed and wires installed underground.

PASCO, WASH.—Bids will be received by L. H. Koontz, city clerk, up to September 19th, for constructing conduits preparatory to the installation of ornamental lamps for street lighting as per plans on file at office of said city clerk.

PASCO, WASH.—Bids will be received by the City Council, L. H. Koontz, city clerk, up to September 26th, for furnishing and installing a quantity of ornamental lamp posts with cluster lights, globes, and equipped with all wiring and conduits.

DORRIS, CAL.—James R. Tapscott, attorney for the Siskiyou Electric Power & Light Company of Yreka, has made application for a 50-year franchise for his company. The matter will be decided on at the meeting of the town board November 6.

PASADENA, CAL.—Residents and property owners of Kenoak Tract have taken steps toward securing a lighting system for Kenoak drive, using an underground system. A committee has been appointed to take up the proposition with city officials and the Edison Electric people.

LONG BEACH, CAL.—The Board of Directors of the Long Beach Consolidated Gas Company has authorized the expenditure of $250,000 for a gas plant to be erected in the northwest section of the city. All gas used by the city will then be piped from a 500,000 cubic foot tank in inner harbor, another tank, called the relief holder, will be erected and a short time afterward a tank with a capacity of 1,000,000 feet will be erected. This will give the entire plant when completed, a capacity of 11,800,000 cubic feet. F. A. Green is manager of the company.

PENDLETON, ORE.—Engineers representing the Pacific Power & Light Company and the Pacific Telegraph & Telephone Company, in a recent conference with the city council, submitted estimates for the installation of underground wires. According to figures compiled by the lighting company's engineers, it would cost the company approximately $20,900 for underground wires on Main and Court streets, while it would cost property owners in the same district $35,000. The company asked the municipality to employ an engineer to verify the reported figures, and which will be considered by the council. The telephone company's report was short and stated that underground wires would cost $20,000.

INCORPORATIONS.

MARTINEZ, CAL.—The Mt. Diablo Telephone Company of Martinez has been incorporated with a capital stock of $5000, by H. C. Wetmore, president; Charles Gordon, secretary; Percy Douglas, treasurer, and twelve others.

SACRAMENTO, CAL.—A $10,307.50 filing fee was paid to the State yesterday when the Pacific Electric Railway Company of Los Angeles, capitalized at $100,000,000 filed articles

of incorporation with the Secretary of State. The new company is composed of eight electric railways, radiating from Los Angeles as follows: Pacific Electric Railway Company, Los Angeles Interurban Railway Company, Los Angeles and Redondo Railway Company, the Riverside and Arlington Railway Company, the San Bernardino Valley Traction Company, the Redlands Central Railway Company, the San Bernardino Interurban Railway Company, and the Los Angeles Pacific Company. These railroads comprise those in which H. E. Huntington is interested. The new board of directors is composed of Wm. F. Herrin of San Francisco, R. C. Gillis and Paul Shoup of Los Angeles, W. E. Martin of San Francisco, and Epes Randolph of Tucson.

SAN JOSE, CAL.—A $2,500,000 company has filed its articles of incorporation with the county clerk here, under which it is planned to operate a line of steamers from Alviso to San Francisco in conjunction with an interurban electric railway from this city. The corporation is known as the San Jose Terminal Railway Company, and the principal stockholders are M. J. Gardner of Stockton, John A. Mehling of San Jose, H. H. McCloskey of San Francisco, Hugh Center of San Jose and Valentine Koch of San Jose. M. J. Gardner, the principal stockholder, is president of the Stockton Terminal Railway.

The articles of incorporation call for the operation of a line of freight steamers between San Francisco and Alviso, as well as passenger boats. The company plans to build a terminal station at Alviso, or rather at Beacon 13, in the San Francisco Bay, on land owned by the Dumbarton Land Company of which H. H. McCloskey of San Francisco is a large owner.

TRANSMISSION.

WILLOWS, CAL.—The Northern California Power Company is planning to enter Arbuckle with its lines.

FOLSOM, CAL.—The Pacific Gas & Electric Company will construct a power line from Folsom to Roseville in the near future.

WEAVERVILLE, CAL.—The bid of the Trinity Dredging Company for a franchise for an electrical transmission line over the county roads near Lewiston in the sum of $144, has been accepted.

PETALUMA, CAL.—The Pacific Gas & Electric Company has decided to extend its power lines from this city to Penngrove and from Petaluma to Mountain View avenue district, and also through the Sunny Slope district.

CHEHALIS, WASH.—Announcement has been made that the Washington-Oregon Corporation would extend its wires to Haskill for the purpose of furnishing power to the rock quarry there and also to furnish lights and power to Littell and Adna en route.

LOS ANGELES, CAL.—The Pacific Gas & Electric Company has decided to construct a large storage reservoir in the Sierra Nevada Mountains several miles above Nevada City to cost about $3,000,000. Two hydroelectric power plants will also be erected.

RIVERSIDE, CAL.—The Edison Electric Company has secured a site near Bloomington depot on which a sub-station will be erected at once. This plant will supply the community with electricity. The company will also install a number of arc lights on the streets.

VACAVILLE, CAL.—Supervisor Glendon presented an ordinance granting to the Pacific Portland Cement Company, Consolidated, a franchise to erect and maintain poles and wires over a certain described public highway in Vacaville township. The ordinance was adopted.

SALINAS, CAL.—Two bids were received for an electric power line over the county roads up the Salinas Valley. One from F. G. Baum, representing the Monterey County Gas & Electric Company for $200, the other was $106, from Frank J. Griffin. The bid of Mr. Baum was accepted.

COLTON, CAL.—The Southern California Edison Company has purchased a block on Mt. Vernon avenue, where it will run a plant in opposition to the Sierra company, which is erecting a plant at San Bernardino. Over $16,000 will be expended on the building here, which will be a two-story concrete structure. This will be the distributing plant for all of this part of the valley.

ONTARIO, ORE.—The contract for furnishing the power for the pumping plants for the Ontario-Nyssa irrigation project has been awarded to the Idaho-Oregon Light & Power Company. The contract is for 25 h.p. for the season, the current to run night and day for six months, the light company to furnish the transformer. The company also contracts to build an electric line along the ditch to accommodate owners of individual pumping plants who desire to raise water above the main ditch for irrigation purposes, and will build such a line one mile for every 10 h.p. contracted for.

TRANSPORTATION.

SEATTLE, WASH.—The Seattle, Renton & Southern Railway, Columbia station, will erect a one-story frame substation at 5033 Rainier avenue, to cost about $1000.

VALLEJO, CAL.—A contract for the grading on the Vallejo & Northern Railroad line within the city of Vallejo will be let soon, says President T. T. C. Gregory of the Vallejo & Northern.

CUCAMONGA, CAL.—Upland parties have stated that the Ontario and San Antonio Heights Electric Railroad will be extended to Cucamonga from Upland provided free right of way can be secured.

LIVINGSTON, MONT.—The Madison River Power Company will extend its line from Livingston to Lewiston, through the Shields River Valley, according to announcements made by General Manager Max Hebgen.

SAN DIEGO, CAL.—The City Council has passed an ordinance granting to the San Diego Electric Railway Company a franchise to construct, maintain and operate for a period ending September 1, 1952, a street railway on certain streets of the city.

SAN JOSE, CAL. An ordinance granting to the Peninsular Railway Company a franchise for a single or double track standard gauge electric railroad in the county of Santa Clara, and also upon Willows street, Selmas avenue and Lincoln avenue, has been passed by the Board of Supervisors.

CHEHALIS, WASH.—The Washington-Oregon Corporation has closed contracts with the State of Washington to supply all electric power for the operation of the convict rock-crushing plant, at Meskill, 12 miles west of this place. Construction of the pole line and installation will start at once.

LOGAN, UTAH.—The Cache County Commissioners have granted a franchise to the Ogden, Logan & Preston Railway Company, to operate within the county an electric or gasoline railway. It is the intention of the company to construct an electric road from Ogden, through the Cache Valley to Preston.

SAN FRANCISCO, CAL.—Announcement is made by General Manager Furlong of the West Side Railway Company that a new electric railway from Sacramento down the river to Rio Vista, tapping some of the rich lands in California, will be in operation within a few months. Actual construction is about to be begun by the company, which is backed by E. R. Lilienthal and associates, who will invest nearly a million dollars in the project.

VALLEJO, CAL.—Extensive plans for the improvement of Vallejo's water front are contemplated by the officials of the Vallejo & Northern Railroad Company as an adjunct of their terminal and grading work in this city. The company owns about 25 acres of tide lands in the vicinity of the foot of Alabama street, where the railroad's terminal will be constructed and it is planned to fill in the tide lands with dirt and rock excavated at other points along the route.

SEATTLE, WASH.—B. H. Graff, contractor, American

Bank building, has received the contract for the construction of a one-story power substation at the foot of Nelson place, for the city of Seattle, at a bid of $8631. The remaining bidders were: S. &C. Carkeek, at $8685; Bartz & Grant, $9556; G. F. Mowat, $10,535; Rounds & Hurson Co., $11,750; A. W. Quist & Co., $12,309; W. G. Clark, $12,500; John Galber, $12,987, and the Butler Construction Company at $14,000.

KOOTENAI FALLS, MONT.—It is reported that a Massachusetts syndicate will shortly undertake the development of 80,000 h.p. electrical energy at this point, for distribution in Western Montana, Northern Idaho and Northeast Washington. J. A. Coram, of Boston, counsel for the corporation, is responsible for the announcement. The plant is proposed to be located seven miles east of Troy, Mont., and at a total cost of $6,000,000 will require two years for completion. The main power transmission lines will be as follows: Kalispell, Mont., 100 miles; Spokane, 90 miles; Wallace, Idaho, 60 miles; Sandpoint, Idaho, 38 miles, and Republic a distance of 140 miles.

FRESNO, CAL.—Promoter F. S. Granger states that he had received $10,000 from the Guaranty Trust Company of New York and the Underwriters Company of Philadelphia. Granger announced that the laying of rails would begin October 15. The material such as ties and rails, will begin to arrive about October 5. Grading work on the interurban line is about completed. To date, 35½ miles have been graded, leaving but a half mile to be prepared. When the ties and rails arrive the laying of track will commence just outside the city and the line will be extended in the direction of Selma as quickly as the work can be done. According to Granger, the grading crew has been doing rapid work and the entire route will be ready for ties and rails by the middle of next week. Granger plans to have the first cars in operation on or about February 1, 1912.

LOS ANGELES, CAL.—With the filing of the incorporation papers of the new Pacific Electric Railroad at Sacramento last week, official announcement was made that its present trackage of 875 miles would be increased to 1875 miles, while the scope of territory made tributary by these extensions would be more than quadrupled. Work on a portion of the new lines is already under way and it is officially stated that construction of the entire system will be carried forward as fast as material can be secured and rights of way and terminal facilities obtained. Here are the extensions which are made a matter of record in the articles of incorporation of the new concern.

The Glendora line will be extended to San Bernardino. The Covina line will be built through Pomona to Riverside. A city trolley service is being installed in Riverside. From the La Habia line a line will be run to Riverside with a branch to Santa Ana. From a point on the Covina line to Long Beach a new cutoff will be run. A line will be built through the San Fernando Valley and to Santa Barbara, with a branch to the town of San Fernando. From Santa Monica a line will be run northeast to San Buenaventura. San Pedro will be connected with Redondo by a new line across the peninsula back of the range of hills. From Santa Ana a trunk line to San Diego will be built. A short line cutoff from the present four tracks will greatly reduce the distance and running time to South Pasadena. Much additional trackage will be installed at many times along the shores of Los Angeles Harbor.

Power for the system, which will be more than doubled when the announced plans are carried into effect, will be supplied by the Pacific Light & Power Company, which already has under construction in the San Joaquin Valley, a plant which is intended to generate greater voltage than now comes from the harnessing of the Niagara.

TELEPHONE AND TELEGRAPH.

PETALUMA, CAL. The Guglielmetti Rural Telephone Company will extend its telephone line to Cotati.

TERRA BELLA, CAL.—The organization of the Ducor-California Hot Springs Telephone Company, a co-partnership company, has been perfected and L. S. Wingrove elected president.

DAYTON, WASH.—An ordinance has been passed by the City Council granting a franchise to the Mount Vernon Telephone Company to build a telephone line along certain streets of the city.

LA PORTE, CAL.—The construction of a new telephone line to the Bellevue mine near Gibsonville and to the Tamarac Flat station near Franklyn Himm on Lunipkin River has been started by the forest service.

ABERDEEN, WASH.—Chesterfield & Van Buskirk, contractors of Tacoma, have been awarded the contract for the construction of the new building to be erected on Market street, opposite the city hall, by the Pacific States Telephone and Telegraph Company, at a cost of $35 000.

NEVADA CITY, CAL.—James Dolan, superintendent of construction in Nevada and Sierra Counties for the Pacific Telephone & Telegraph Company, is awaiting orders from the head office to start the construction of a new telephone line from Camptonville, Yuba County, to Loyalton, Sierra County, a distance of over 80 miles.

WATERWORKS.

WAPATO, WASH.—Wapato residents have decided to adopt the municipal waterworks system as prepared by Engineer Redman.

SISSON, CAL.—This town has voted in favor of a bond issue of $40,000 for the construction of a water plant and the building of a city hall.

OXNARD, CAL.—Engineers are preparing plans for a municipal water system to cost about $100,000. A bond election for improvements will be held soon.

REDLANDS, CAL.—Engineer Hinckley has completed plans for the construction of an independent system of water mains for the business section of this city for fire protection use.

RENO, NEV.—Bids were received by the Board of Trustees of the town of Alturas, Modoc County, Cal., up to Sept. 13, 1911, for the construction of the waterworks of the town of Alturas.

SAN DIEGO, CAL.—The Hazard Gould Company has been awarded the contract for extending the Sweetwater water system to the Fairfield tract on the bay side of Chula Vista. This will cost about $4000.

CENTRALIA, WASH.—The construction of a joint water system for the city of Centralia and Chehalis to be owned and operated by the cities, is a feasible proposition. The approximate cost is estimated at $115,000.

ORANGE, CAL.—The City Council has passed a resolution determining that public interests and necessity demands the construction of a water system, also the construction of a waterworks building at a cost of about $50,000.

SPRAY, ORE.—S. L. Cross and S. C. Johnson are to put in a water system for the town. A well ten feet in diameter is being dug in Spray. Additional water will be pumped through two-inch mains to a concrete tank 20x30.

OGDEN, UTAH. The David & Weber Counties Canal Company has awarded a contract to the Lynch-Cannon Company for the erection of its waterworks plant near Riverdale. This improvement when completed will represent an investment of $250,000.

LYLE, WASH.—The Puget Sound Bridge & Dredging Company, Central building, Seattle, is assembling materials and equipment for the construction of the Northwestern Electric Company's dam on the Klickitat River, near this city. The dam will be utilized to irrigate 6500 acres by ditch and will cost $100,000. The completed survey demonstrates, it is stated, the practicability of a project to cost $500,000.

JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

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THE BIG MEADOWS DAM

In constructing the Big Meadows dam, the Great Western Power Company will place before engineers and investors a very interesting piece of work. This dam when completed will back up the flood waters of the Sierras, submerging 25,600 acres of land, thereby impounding 1,160,000 acre ft. of water. It will be 720 ft. long on top and 150 ft. high over all. By the employment of the Eastwood Multiple Arch type less than 30,000 cu. yds. of reinforced concrete will be necessary in its construction.

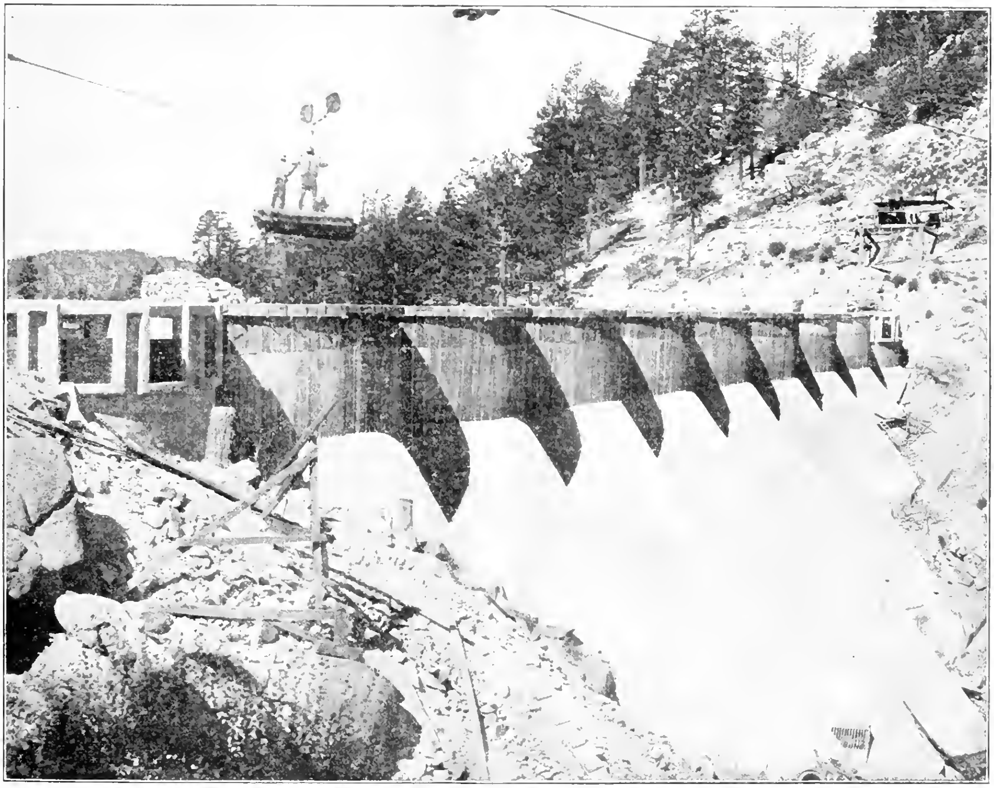


Fig. 1. Big Bear Valley Dam in Southern California, nearing completion. Type of dam adopted in the Big Meadows project

It is interesting to compare this dam with other similar reservoir dams. There are but three that can be put in the same class. These are the Ashokan, the Roosevelt and the Assouan dams. The Ashokan dam of the New York water supply submerges 8300 acres of land, thereby impounding 368,030 acre feet of water. The dam is 1000 ft. long on top and 180 ft. high; 884,000 cu. yds. of masonry and 7,000,000 cu. yds. of earth work were necessary in its construction and its cost was $12,669,755. The Roosevelt dam of the

U. S. Reclamation Service submerges 16,320 acres of land, thereby impounding 1,284,000 acre feet of water. The dam is 1080 ft. long on top and 280 ft. high; 332,300 cu. yds. of material were necessary in its construction and its cost was $3,470,000. The Assovan dam in Egypt was first built to submerge 40,000 acres of land thereby impounding 863,000 acre ft. of water. The original length was 6400 ft. and height 130 ft., necessitating 700,000 cu. yds. of masonry at a cost of $12,250,000. It has since been increased to 1,500,000 acre ft., but the final cost and dimensions are not available.

The present project for the building of the Big Meadows dam produces the cheapest reservoiring per acre ft. of any project of its size in the world. The comparative small amount of concrete (30,000 yards) is due in a great measure to the natural endowments of the dam-site. In Fig. 2, as one looks down stream, the cleared portion is the location decided upon. Nevertheless a saving of $500,000 is made by the particular design of dam selected over a cyclopean masonry

Fig. 2. Damsite at Big Meadows. Looking Down Stream.

dam. The dam-site is located one mile below Nevis, Plumas county, California. The dam will be 150 ft. high over all, the burden being 34 ft. in depth. The bed-rock formation is a gray lava or basaltic rock. The drainage area from which the waters to fill the enclosure will be drained comprises 480 sq. miles of the snow-capped Sierras. It is now definitely planned to have the dam completed by the fall of 1912 so as to benefit by its water storage during the dry season of 1913.

The dam is to be of the Eastwood multiple-arch type. John S. Eastwood, the originator of the design employed is to be the engineer in charge. There will be 22 spans of 30 ft. each, and in addition an automatic spillway constructed with straight walls and a concrete apron. Fig. 3 shows the skeleton of an Eastwood multiple arch type of dam. This is a picture of the Big Bear Valley dam near Redlands, California, now in course of erection. Fig. 1 shows the same dam almost complete. This dam which has thus far proved thoroughly satisfactory although as yet not fully tested is 92 ft. over all in height, 363 ft. long. It contains 4684 cu. yds. of material and impounds 63,000 acre ft. of water.

The North Fork of the Feather River has its source in springs rising in the Big Meadows. It flows out of the Meadows through a narrow gorge which provides a natural and inexpensive site as detailed

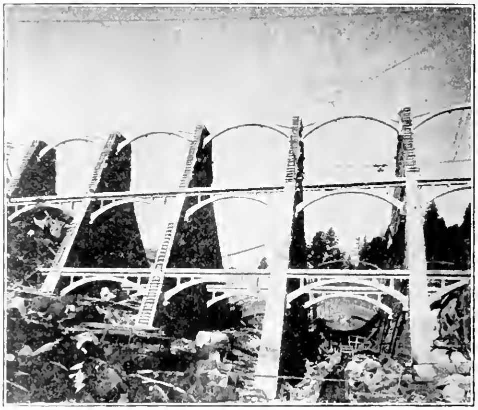


Fig. 3. Skeleton view of Big Bear Valley Dam, illustrating Eastwood Multiple Arch Type to be used in Big Meadows project

above for a dam by the construction of which there can be impounded in the Big Meadows enormous quantities of water. The natural minimum flow of the river is approximately 1000 cu. ft. per second. This

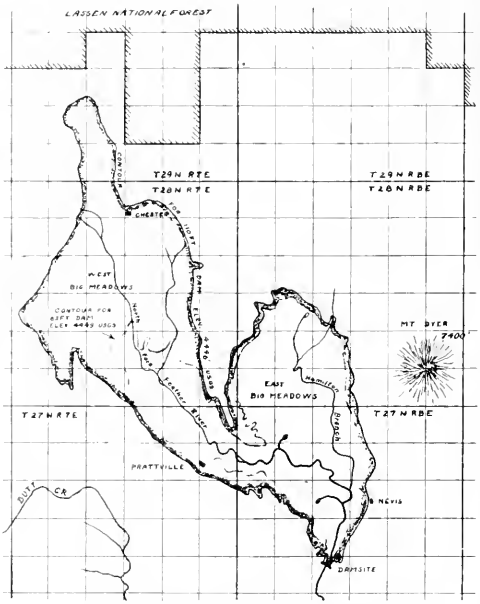


Fig. 4. Area to Be Flooded by Waters Impounded in Big Meadows When Dam is Completed.

flow will be increased to 1500 cu. ft. per second as the result of the construction of a 63 ft. dam, and 2500 cu. ft. per second when the dam is raised to its full height of 110 feet as contemplated.

The combined minimum flows of all the rivers upon which power is now being developed to supply Oakland and the territory east and north to Oroville do not exceed that of the North Fork of the Feather River. The storage possibilities on these several streams do not equal that of the Big Meadows alone. The by-product value for irrigation of the waters stored in the meadows after they have been converted into electric energy is sufficiently great to warrant the belief that in time substantial revenue to the company will accrue from this as yet little considered source.

At Big Bend, eighteen miles above Oroville, and one hundred and fifty-three miles northeast of Oakland, the company has installed in successful operation a hydroelectric plant with a total capacity of 55,000 electrical horsepower which will be increased in the near future to 70,000 horsepower. This plant consists of a masonry dam 85 ft. high and a concrete intake tower through which the water is delivered under pressure to a concrete lined tunnel driven through the solid rock for 15,000 ft., from which it passes by means of a steel header and pressure pipes to four water wheels directly connected to electric generators. The water is utilized under a head of 455 ft. at which head the natural minimum flow of the river is sufficient for the present installation. When the flow of the river is increased to 2500 cu. ft. per second by the development of the Big Meadows storage, this plant can be increased to 110,000 electrical horsepower by merely adding the necessary generating units, the intake tower, tunnel, and header having been constructed of sufficient size to accomplish this result.

The power generated at Big Bend is transmitted 153 miles to Oakland over two circuits, each consisting of three copper cables suspended from steel towers set in concrete foundations. The power, which is transmitted at 100,000 volts, is reduced to make it available for commercial use by means of apparatus installed for that purpose in concrete substations located at Sacramento, Brighton, Antioch, Cowell and Oakland. From these substations secondary distributing circuits carry the current to the customers of the company. Each substation can, through its secondary distributing system, supply customers within a radius of twenty-five miles.

Between the Big Meadows and the present plant at Big Bend, the North Fork of the Feather River has a fall of 3400 feet, much of which can be used for power purposes. The opportunities for the profitable use of this fall are practically all controlled by the company. With the amount of water which will be made available by the Big Meadows storage these developments will, it is estimated, produce 500,000 horsepower.

On the estuary in Oakland, an unusually favorable location for securing condensing water and supplies of fuel oil by barge, pipe line or railroad, the company has erected a concrete and steel power plant containing water tube boilers and three steam turbines each directly connected to electric generators of a combined capacity of 15,000 electrical horsepower. This plant is in reserve for emergencies and as an assurance to customers of continous service.

The steam plant in San Francisco consists of a steel and concrete building, water tube boilers having a capacity of 20,000 horsepower and steam turbines directly connected to electric generators having a capacity of 28,000 electrical horsepower. Additional boiler capacity can be installed in the present building. From this power station, by means of conduits in the business district, and over head lines in the residence sections, the company supplies a large amount of current for lighting and power in San Francisco.

Physical connections between the plants in San Francisco and Oakland will in a few months be effected by means of cables under the Bay of San Francisco. This will make it possible to use in San Francisco the low cost hydroelectric current generated in the mountains at a very substantial saving over that generated by steam from fuel oil. It also makes available, as a reserve for the entire system, the steam plant in San Francisco which can now be used only for that district. The combined capacity of the power plants now in operation is 98,000 electrical horsepower.

The Great Western Power Company, the owner of these properties, has had an interesting history. It had its inception in 1900 and after six years devoted to the acquisition of lands and water rights and preliminary engineering and investigation, was incorporated in 1906. Construction of its power plant at Big Bend was started the same year, continued without interruption during the panic of 1907, and was completed in 1909. The company has been in successful commercial operation for eighteen months. In 1908 the California Electric Generating Company, a subsidiary of the Great Western Power Company, completed its steam plant in Oakland, it having been erected as a reserve to the hydroelectric plant. The company has but recently taken over the City Electric Company of San Francisco by purchase of its capital stock. The plant of the City Electric Company in San Francisco was completed in November, 1907, and has since been in continuous operation.

The Great Western Power System, which term is used to designate the property of the company and its subsidiaries, including the City Electric Company, consists of hydroelectric properties on the North Fork of the Feather River in California; a steel tower transmission line from the Big Bend power plant to Oakland; substations at Sacramento, Brighton, Antioch, Cowell and Oakland and secondary distributing lines radiating therefrom, and underground and overhead distributing systems in San Francisco, a steam plant in Oakland and one in San Francisco.

ELECTRICITY IN AGRICULTURE.

So far as wheat is concerned the beneficial effect of electricity has been amply demonstrated by experiments already carried out. With three different fields of wheat, each growing electrified and non-electrified crops, so distinct was the improvement in the electrified crop that a line of demarcation in the field could be plainly seen. Satisfactory experiments have also been tried here upon sugar beet. In Germany experiments have been carried out with an electrified spray of water in order to get over a difficulty which has been encountered, namely, that electrified crops produce less in dry weather.

PRIMER OF APPLIED THERMODYNAMICS.[1]
FIFTH LECTURE.

Laws of So-called Perfect Gases.

During the last lecture the results of applying heat to a pound of ice at 0° F. until it was finally evaporated into steam was followed step by step. As long as any water remains, the steam or gas being formed has peculiar properties as compared with the steam or gas when its temperature is raised considerably beyond the evaporation point for the particular pressure at which the evaporation of water in steam takes place by a slight increase in heat, or what is practically the same thing the condensation of steam back into water by a slight decrease of heat. Where steam is thus heated beyond its condensation point, it is said to be superheated, and like all other gases heated beyond their condensation point, it obeys almost perfect laws, which are known as laws of perfect gases. Among the socalled perfect gases may be classified air, hydrogen, oxygen, superheated steam, ammonia, carbonic acid, and a number of others.

Years ago a scientist named Boyle took an enclosed tube of the form A B C D E, and put one of the socalled perfect gases in D E and then poured mercury B C D, into the tube, thus compressing the gas in D E. Now it is evident that the weight of the column of mercury BC, added to the atmospheric pressure will give at once the total pressure on the gas in D E. By pouring in more mercury at A, Boyle

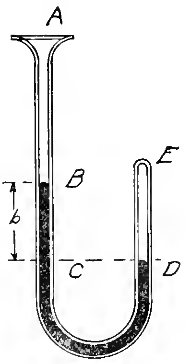


Fig. 15. Boyle's Experiment in Establishing His Law of Gases.

found a wonderful relation which is still known as Boyle's Law of Gases. He found that as the pressure was increased the volume of the gas diminished, and in such a way that the product of the pressure and volume always remained constant. Thus, if the volume was 2 cu. in. at 14.7 lb. pressure, it would be reduced to 1 cu. in. by application of 29.4 lb. pressure.

Putting this law into algebraic form we have

$p\ v =$ a constant,

or $p\ v = p_0\ v_0$,

where $p =$ pressure per square foot,

$v =$ cubuc feet per pound,

$p_0 =$ pressure per square foot, usually at 32° F.,

$v_0 =$ cubuc feet per pound, usually at 32° F.

In 1806 Charles found another very remarkable law of gases. He found that by keeping a gas under a constant pressure and applying heat, a definite increase in volume would result. Now Charles found definitely that if, for instance, he started with a gas at 0° C., no matter what the pressure as long as he maintained it constant throughout his experiment, when he had applied sufficient heat to raise its temperature to 1° C., the gas had increased 1/273rd of its volume. Expressed mathematically, this becomes

$$v = v_0\ (1 + t/273)$$

where $v =$ cubic ft. per pound of gas,

$v_0 =$ cubic ft. per pound of gas at 0° C.,

$t =$ degrees centigrade.

By observing this equation, we see that if a gas be cooled, there would be a point where its volume would be practically nothing. Such a point would be reached at — 273° C. or 491.4° F. below the freezing point of water. Now since the freezing point of water is 32° on the Fahrenheit scale, to convert temperatures to absolute Fahrenheit scale, we must add 459.°4 to the number of degrees Fahrenheit, and to convert temperatures to the absolute Centigrade scale, 273° to the number of degrees Centigrade.

It will be evidently a matter of great convenience in computation, and in the study of gases, if a single equation is devised that will represent both these laws above stated.

Such an equation is

$$pv = R\,T,$$

where $p =$ the number of lb. per sq. ft.,

$v =$ the cu. ft. per lb.,

$R =$ a constant,

$T =$ degrees Fahrenheit on absolute scale.

Evidently from this equation we can find the value of R for any perfect gas if we know its volume at any given temperature and pressure, and having once determined its value, ever afterwards any pressure or any volume, or any temperature can at once be computed when two of these factors are known.

In the case of air and its application in the air compressor, we know that one lb. of air has a volume of 12.39 cu. ft. under atmospheric pressure of 32° F. Now as we have previously seen, atmospheric pressure amounts to 14.7 lb. per square inch. In our formula this pressure must be multiplied by 144 in order to compute the pressure per sq. ft., and as 32° F. is equal to 491.°4 F. in the absolute temperature, we now substitute in our formula

$$p\,v = R\,T$$

$$(14.7 \times 144) \times 12.29 = R\ (491.4)$$

$$\text{or } R = 53.37.$$

Hence for air we have

$$p\,v = R\,T,$$

$$\text{or } p\,v = 53.37\ T.$$

This equation is always true for air, hence let us take a practical computation. In an air compressor chamber we have 10 lb. of air at 200° F. The cubical contents of the chamber amount to 120 cu. ft. What must be the pressure?

[1] A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

$$T = 459.4 + 200 = 659.4 \quad v = \frac{120}{10} = 12$$

hence— $$p = \frac{53.37 \times 659.4}{12} = 2950 \text{ lb. per sq. ft.}$$

In the solution of problems such as this, the slide rule is found most convenient and the result is probably correct within 2 per cent.

Taking another illustration, how many pounds of air does it take to fill 5600 cu. ft. at 15 lb. pressure per sq. in. and at 60° F?

Here $p = 15 \times 144$; $T = 459.4 + 60 = 519.4$,

$$v = \frac{519.4 \times 53.37}{15 \times 144} = 12.9,$$ and as this is the volume of 1 lb., 5600 cu. ft contain $\frac{5600}{12.9} = 434$ lb. of air.

It is evident that if we can introduce into our general equation some slight modification in order to obtain weights directly, it will be a little more convenient in the solution of such problems as the above.

Let V = total cu. ft. of a gas.
v = cu. ft, per lb.
W = weight in lb.

Then $W \times v = V$

$$\text{or } v = \frac{V}{W}$$

Substituting in our formula,

$$p\,v = R\,T,$$

$$\text{we have } p\frac{V}{W} = R\,T,$$

$$\text{or } W = \frac{p\,V}{R\,T}$$

In the last problem, above mentioned, we can now substitute and solve directly; thus:

$$W = \frac{p\,V}{R\,T} = \frac{15 \times 144 \times 5600}{53.37 \times 519.4} = 434 \text{ lb. of air.}$$

Having now determined a definite value of "R" in the case of air, we shall next discuss an accurate and beautiful method of determining its value for any other perfect gas, by simply knowing its specific density. Before, however, illustrating this method, it will be instructive to discuss one more law of gases. Dalton, in 1807, gave forth to the world the law of partial pressures, summarized in the following sentences. Two gases at the same temperature, provided they do not interact chemically, do not interfere with each other's pressures when mixed. Thus, if they are forced into the same volume, the pressure of the mixture is equal to the sum of those of the components. The gases are, therefore, still thought of individually, and the share which each gas has in the total pressure is called its partial pressure. For example, a gas measured over water contains water vapor. The partial pressure of this, called the aqueous tension, which is definite for each temperature, must be substracted from the total pressure.

Now if the gases do act upon one another chemically, we must very carefully consider the new relationship. The difference in the two cases can be better seen from a comparison by illustration. First take air as an example of a mixture of two gases. As we have previously seen, air contains four parts by volume of an inert substance known as nitrogen and one part by volume known as oxygen. Each part of nitrogen has 14 units of weight as compared to 16 units of weight for each part of oxygen. Placing these 5 parts together we should have a total of 72 units of weight, which would occupy 5 units of volume. Then evidently 1 unit of volume of air would have 14.4 units of weight. Oxygen gas has 16 units of weight as we have just seen. In our formula $p\,v = R\,T$, which we have found true for all perfect gases, it is clear that if we are considering a gas that is, for instance, twice as heavy as air, v would be but one-half, and consequently R would have to be but one-half. Hence to compute R in any given case, since we know R for air, we have a simple relationship, that the R for the new gas is to the R for air as the relative density of the air is to the relative density of the new gas. Thus to find R for oxygen, we have

$$\frac{R_o}{R_a} = \frac{14.4}{16}$$

$$\text{or } R_o = \frac{53.37 \times 14.4}{16} = 48.1$$

To compute the relative density of a mixture of two gases which have undergone a chemical change, we must proceed very carefully, taking into account the laws of chemical reaction. Let us take the case of superheated steam, or H_2O, which means that 2 units by volume of hydrogen have been mixed and chemical reaction taken place with 1 unit by volume of oxygen. If no chemical reaction had taken place, we should proceed to compute its relative density exactly as in the case of air. Thus we should take two units of volume of the hydrogen, which represents two units of weight also, and add one unit of oxygen, which represents 16 units of weight, thus making 3 units of volume, in all, representing 18 units of weight. Hence 1 unit of volume would represent 6 units of weight. This is incorrect, however, as chemical action has taken place, and the two hydrogen units have combined with the one unit of oxygen to form steam or H_2O. It is found by experiment that the volume occupied by the new compound is twice as much as the oxygen under the same condition of pressure and temperature. Hence the weight of the new compound or rather density is one-half of the 18 units above referred to or in this case 9. Therefore to compute R for steam, we have

$$\frac{R\ (\text{steam})}{R\ (\text{air})} = \frac{14.4}{9}$$

$$\text{or } R \text{ (steam)} = \frac{53.37 \times 14.4}{9} = 85.6$$

Similarly for other gases, we find values in the following table:

	Relative Density.	R Value.
Air	14.4	53.4
O	16.	48.1
H	1.	770.
N	14.	54.9
CO_2	22.	35.
NH_3	8.5	90.6
CO	14.	54.9
H_2O (steam)	9.	85.6

We must observe caution in using too freely the above formulas, for at our ordinary pressures and temperatures, the gas may be too near its condensation point, and we shall find that the law for perfect gases will not hold when a gas becomes a saturated vapor or even too near this point. With proper discretion in their use, however, the above will be found sufficiently accurate for their ordinary application.

THERMOTWISTERS.

1. Find the volume of one pound of air in an air compressor at a pressure of 100 lb. per sq. in., the temperature being 32° F., using Boyle's law only.

2. From Charles' law, find the volume of one pound of air at atmospheric pressure and 72° F.

3. Find the temperature of 2 ounces of hydrogen contained in a 1-gallon flask and exerting a pressure of 10,000 lb. per sq. in.

4. How large a flask will contain 1 lb. of nitrogen at 3200 lb. pressure per sq. in. and 70° F?

SOLUTION OF THERMOTWISTERS—SECOND LECTURE

1. Convince yourself of the enormous amount of latent energy stored in 10 lb. of coal. Assume that each lb. of coal has a calorific value of 14,500 B.t.u. Convert into mechanical energy and estimate the vertical aerial journey you could take on this energy, were it exploded under you and your body were able to absorb all the energy.

Total calorific value of coal.

$$= 10 \times 14{,}500 = 145{,}000 \text{ B.t.u.}$$

145,000 × 778 = 112,800,000 ft. lbs., of energy represented.

Assuming my weight at 175 lb., it would require 175 ft. lb. to lift me 1 ft. Hence I would be lifted a total distance of

$$\frac{145{,}000 \times 778}{175} = 641{,}500 \text{ ft. Ans.}$$

or about 123 miles.

2. In a heat engine test, each pound of steam leaves the engine containing 125.2 B.t.u. less heat than when it entered the cylinder. The engine develops 155 h.p., and consumes 3160 lb. of steam per hour. Compute the mechanical equivalent of heat.

$$155 \text{ h.p.} = 155 \times 33{,}000 \times 60 \text{ ft. lbs. per hour.}$$

Since 125.2 B.t.u. leave each lb. of steam for a total of 3160 lb., we have

$$3160 \times 125.2$$

Hence mechanical equivalent of heat

$$= \frac{155 \times 33{,}000 \times 60}{3160 \times 125.2} = 775 \text{ Ans.}$$

3. In a test to determine the calorific value of anthracite coal by means of a Parr Calorimeter, ½ gram of the coal was properly burned and a temperature rise of 2.040° C noted. How many B.t.u. of heat per lb. of coal?

On page 228, we find

$$C = (t - 0.006^\circ) \times W \times 0.73$$

Since W = 2 kilograms we have

$C = (2.040 - 0.006) \times 2 \times 0.73$ calories per ½ grm. of fuel.
or $2.034 \times 2 \times 0.73 \times 2000$ calories per kilogram of fuel.

Since 1° C = 9/5° F. and 1 kilogram = 2.205 lb., we have

$$\text{B.t.u. per lb of fuel} = \frac{2.034 \times 2 \times 0.73 \times 2000}{2.205} \times 9/5 = 4850. \text{ Ans.}$$

4. A piece of cast iron bar, weighing one-half lb., is thrown into the furnace and heated to the temperature of the fire, and is then withdrawn and placed in a pail containing 10 lb. of water. The original temperature of the water was 60° F., and after immersion of the iron, the temperature rose 20°. Find temperature of the furnace.

On page 227 we find specific heat of cast iron is .180.

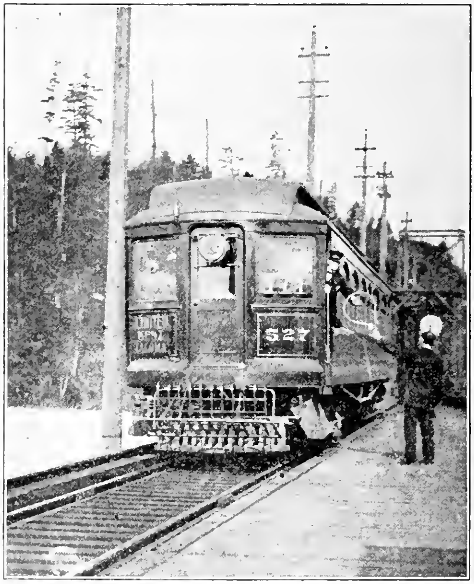
$$X = T + \frac{W t}{W S}$$

$$\text{or } X = 60 + \frac{10 \times 20}{0.5 \times .180} = 60 + 2222 \text{ or } 2284^\circ \text{ F. Ans.}$$

INTERURBAN RATE MATTERS IN THE NORTHWEST.

The supreme court of the State of Washington has recently handed down a most important decision relative to the rate struggle of electric railways operating in suburbs of Tacoma and Seattle. The case in question being that of the Puget Sound Electric Railway Company, appellant, against the railroad commission of Washington ex rel W. H. Paulhamus, respondent, and David Hart and others, intervenors, sustaining the Thurston county superior court in upholding the order of the railroad commission which reduces the rates on the interurban between Seattle and Tacoma for a distance of twelve miles out of each city, and which cuts the rates on the Seattle-Renton line and the Tacoma-Puyallup line.

The first rates were established when the company started business in 1902, and they prevailed until October 17, 1909, when the company put in its new rates, which resulted in almost depopulating the smaller suburbs, which were inhabited by the workers of Seattle and Tacoma, who had acquired land for small homes because of the low rates. It was shown



Limited Train, Puget Sound Electric Railroad. This is the road the new rate decision will directly affect.

that they could not afford to pay the new rate, therefore the commission held it was unreasonable.

Chairman H. A. Fairchild, of the commission, declares that the decision is the most important that has ever been made in the Washington court on the subject of rate making

The court takes the same view the commission does: That 7 per cent is not an unreasonable return on an investment; that mistakes of the company in the past cannot be assessed to the traveling public (for it was shown that since being organized the company has not set aside a proper sum to cover depreciation).

"The importance of the decision is not measured by the relief granted to the patrons of this road," says Mr. Fairchild. "It is in the principles enunciated, which will be authoritative in the determination of future rate hearings.

"The court, in an exhaustive review, sustains the commission in its holding that the maximum charge that can be made by a public service company is the value of the service to the patron (provided the charge pays the cost of the extra service rendered) irrespective of whether the particular charge will be remunerative to the stockholders.

"The railroad company contended that, while it might properly voluntarily reduce the charge for a particular service to a point that was not compensatory, the commission possessed no such authority and must be guided solely by a consideration whether the rate was remunerative; that this was a question of policy, and when the commission ordered in a rate that, standing alone, was an unremunerative rate, it usurped the functions reserved to the company.

"The effect of the decision is to permit the commission in dealing with particular rates to consider all the elements and surroundings that would influence an honest traffic manager in putting in or changing such rate.

"Many questions affecting valuation of railroads are settled by the decision. From a commission standpoint, it is the most important decision handed down by our courts.

"In my opinion, the order affirmed will result in an increase of net returns to the company. The rates ordered reduced affect only approximately 10 per cent of the company's revenues, and the increase in travel by reason of the reduced rates will, in my judgment, result in a benefit instead of an injury to the railroad company."

ELECTRICAL JOBBERS AT PORTLAND.

The Pacific Coast electrical jobbers met at Portland, Oregon, on September 21, 22 and 23. They played some golf, saw some baseball and heard some papers. The golf tournament was won by R. D. Holabird, who still holds the cup. The baseball was of the professional series which is not yet completed. The papers will appear in subsequent issues of this publication.

The papers read and discussed included "Cost of Doing an Electrical Supply Business," by R. D. Holabird of San Francisco; "What Should Constitute Assets of a Company," by R. H. Gregory comptroller of the Western Electric Company, and "How to Overcome the Practice of Selling Staple Commodities at a Loss," by F. M. Bernadin.

At the banquet on Friday evening a number of manufacturers' representatives also joined the party, having been invited to be in Portland at the time. These included S. D. Vandergrift of the National Electric Lamp Association; H. E. Sanderson of the Bryant Electric Company; Irving H. Shorno of the General Electric Company; Henry R. Behneman, manager of John R. Cole Company's Seattle house; A. E. Barlow and C. E. Johnson of the American Ever Ready Company; C. E. Gregory of the Arrow Electric Company; F. G. Larkin, Seattle representative of the Telephone Electric Equipment Company, and M. D. Stearns of the Standard Underground Cable Company.

The meeting was unanimously declared to be one of the most successful yet held, being characterized by an excellent spirit of co-operation in electrical trade circles on the Pacific Coast. Portland's beauties of climate and scenery were fully enjoyed especially by those participating in the golf tournament at the Waverly Golf Club.

The formal meeting adjourned at noon on Saturday, some leaving for San Francisco and some for Seattle later in the day, others staying to enjoy the hearty hospitality of the web-footers.

SEATTLE BRANCH MEETING OF AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The members of the Seattle Section of the American Institute of Electrical Engineers met at dinner at the Arctic Club on the evening of September 16. This being the first meeting after the summer recess no formal paper was presented. Secretary Whitney reported the business transacted at the Chicago national meeting and Chairman A. A. Miller outlined a comprehensive plan of action for the next year. In all likelihood a Pacific Coast meeting will be held at Seattle about the time of the National Electric Light Association's convention there.

MINE PRODUCTION IN 1910 AS REPORTED BY THE U. S. GEOLOGICAL SURVEY.

The mine output of gold, silver, copper and lead in California in 1910 had a value of $27,020,405, according to figures compiled by Charles G. Yale and just made public by the United States Geological Survey. The production of gold was $19,715,440; that of silver 1,840,085 fine ounces, valued at $993,643; that of copper 48,700,756 pounds, valued at $6,184,996; and that of lead 2,870,977 pounds, valued at $126,323.

These figures show a decrease in the output of gold, silver, and copper as compared with the figures for 1909, but a large increase in lead. The 1909 figures are as follows: Gold, $20,237,870; silver 2,098,253 ounces, valued at $1,091,092; copper 57,288,281 pounds, valued at $7,447,476; lead, 1,502,597 pounds, valued at $64,612.

PRESERVATION OF POLES.

An interesting fact disclosed by the figures from the recent census statistics is the rapid growth of the practice of treating poles in order to prolong their period of use. In 1910 824,673 poles, or more than 21 per cent of the total reported purchases for that year, were given some preservative treatment. This number was an increase of 248,042 poles, or 43 per cent over that of 1909; 480,285, or 139.5 per cent over that of 1908; and 428,474, or 108.1 per cent over that of 1907. In 1910 the class of pole users which applied preservatives most extensively was the electric railroad, light, and power companies, 29.4 per cent of the reported purchases having been given some treatment of this character, as against 19.9 per cent by steam railroads and 19.4 per cent by telephone and telegraph companies.

GENERATING PLANTS AT VICTORIA FALLS.

The Victoria Falls & Transvaal Power Company has at present three generating stations in South Africa, the old one at Brakpan and two new ones at Rosherville and Simmer Pan, while the foundations for the station at Vereeniging are now being proceeded with.

The Simmer Pan plant comprises six impulse turbines of 4500 brake horsepower each. The generation is three-phase, 50 cycles of 5000 volts transformed to 10,000, 20,000 and 40,000 volts, as required. The whole system is managed from the control room, which is in charge of an engineer in telephonic communication with every part of the system. The scale of prices is as follows (1 penny = 2 cents):

Load factor. Per cent.	Per unit from Oct. 1, 1910, to Sept. 30, 1912. Pence.	Per unit after Oct. 1, 1912. Pence.
10	2.512	2.475
15	1.754	1.717
20	1.375	1.338
30	.995	.958
40	.807	.770
50	.692	.655
60	.617	.580
70 and over	.5617	.525

The actual cost of generation has not transpired, but at the station of the Randfontein Central, where coal costs more in consequence of 25 miles extra haulage, the cost has been brought down to below a farthing (½ cent) per unit at the switchboard and 0.4d. (0.8 of 1 cent) into motors all over the property. When the central mill is in full operation and the amount generated increased, with consequent spreading of the standing charges, it is confidently expected that these figures will be improved upon.

The stations of the Victoria Falls Company are being worked at their fullest capacity, the Rand mines requiring considerably more power than they originally contracted to purchase. At some mines, consequent upon the scarcity of hammer boys, the old steam plants have lately been started up so as to supplement the supply of electricity and compressed air in bulk.

AMERICAN EXPORTS.

According to the American Manufacturers' Association's reports the increase in the exported manufactures of the United States in the last year was almost $150,000,000; while the total values of those products had reached $915,000,000 in the last fiscal year. The coming convention will be unique in many ways. It will bring together for the first time in the history of American commerce the leading exporters, manufacturers and export managers in the United States.

PACIFIC COAST GAS ASSOCIATION.

In the following columns will be found a continuation of the papers read before the recent convention, in Oakland, of the Pacific Coast Gas Association. Committee reports will be found appended before the editorial page of the Journal. The paper of Professor C. L. Cory, started in the last issue of the Journal, will be found concluded in this issue:

THE NAPHTHALENE PROBLEM IN OIL GAS MANUFACTURE AND DISTRIBUTION.

BY F. S. WADE.[1]

In the following paper I will not attempt to offer any new theories concerning naphthalene, its formation, its deposition, its removal; too many have already been offered. I will only endeavor to state the theories which most clearly follow invariable physical laws and the facts as I have observed them.

Let us first consider the nature and origin of naphthalene. As we only too well know, it is a white crystalline, solid hydrocarbon, 93.7 per cent carbon and 6.3 hydrogen; it has a melting point of 176° F. and boils at 424° F. At the ordinary temperature, its vapor tension is very low, but, as will be seen by the attached curve, one that rises very rapidly with increases in temperature above about 90° F. It has the rather peculiar property of passing from a vapor to a solid with no intermediate liquid condition, and this property, more than any other, causes its intensely objectionable features as a hydrocarbon in illuminating gas.

Naphthalene is quite generally formed when organic substances are decomposed at a red heat. For example, it is readily made in the laboratory by passing alcohol, ether, benzine and acetic acid through red hot tubes. I have made, when experimenting with the decomposition of California petroleum in a small iron retort, at a temperature below 1600° F., naphthalene in sufficient quantities to quickly stop up a ⅜ in. off-take pipe. It may, therefore, be safely stated that any process of making gas, of say 20 candle-power, or 640 B.t.u. from petroleum, will make more than enough naphthalene to saturate gas as it leaves the wash-box at a temperture of, say 150° F. This statement is readily proved by the fact that a small quantity of solid naphthalene is invariably found in the carbon from the wash-box, showing that an excess of naphthalene crystallized out when the hot gas coming from the generator was cooled on striking the water in the wash-box. There can be no doubt that very high temperatures in the generator make excessive quantities of naphthalene, but this extra amount will appear only as a greater percentage in the carbon and tar; places where it does no particular harm. It is my opinion that any effort looking to the elimination of naphthalene trouble by doing away with its formation in the generator is misdirected.

If we admit that considerable quantities of naphthalene will be made by the oil gas process under the most favorable circumstances of manufacture, the question then becomes how best to prevent its depositing in troublesome quantities and places.

The vapor tension of naphthalene is such that the following quantities are carried by gas when saturated:

Temp. Deg. F.	Grains per 100 cu. ft.
50	7
60	13
70	24
80	42
90	71
100	117
110	182
120	276
130	403
140	628

[1] Chemist, Los Angeles Gas & Electric Corporation.

At these various temperatures, 100 cubic feet of gas can carry the number of grains stated and no more. It is, therefore, evident that if gas leaves a works saturated with naphthalene at 80° F. and encounters somewhere in the distributing system a temperature of 60° F., 29 grains of naphthalene will be deposited for each 100 cubic feet of gas. And worst of all, wherever a drop in temperature is encountered, naphthalene is deposited in a small space in the form of thin crystalline plates growing out from the interior surface of the pipes at right angles to the flow of gas. This habit of crystallization enables a minimum weight of the solid to offer a maximum of obstruction to the flow of gas.

A great deal has been said and written about the effect of water vapor, benzol, ammonia and other vapors upon the deposition of naphthalene. Experiments to study these points were made by holders of the Gas Engineering Fellowship of the Michigan

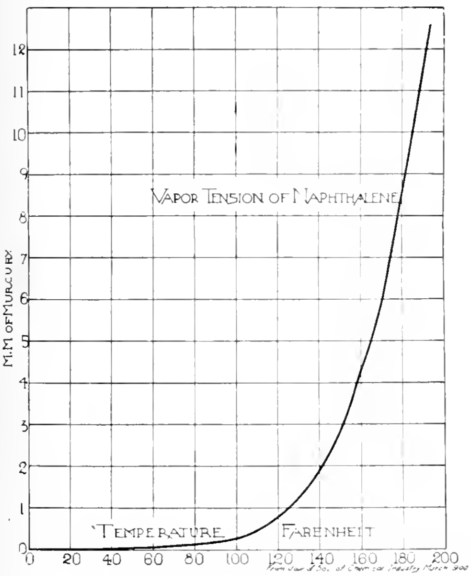


Chart Showing Vapor Tension of Naphthalene.

Gas Association at the University of Michigan under scientific conditions which would be difficult to duplicate in the industrial gas laboratory. The results of these experiments were published in the proceedings of the Michigan Association for 1905, and may be consulted at length therein. It was found that, with the single exception of gas containing benzol vapor, the nature of the mixed vapors or gases, of which naphthalene vapor formed a part, had no effect upon the vapor tension of naphthalene. In other words, crystals of naphthalene would be deposited in the same quantities at the same temperature from air, hydrogen, acetylene, dry coal gas, coal gas saturated with moisture, or heavily charged with ammonia. It appeared that gas containing a considerable amount of benzol vapor was able to carry a greater quantity of naphthalene without deposition. Benzol is not, however, found in sufficient quantities in oil gas to have any serious effect.

In view of these facts, it may be safely stated that the only important factor in naphthalene deposition is temperature change. It may also be stated, that so long as gas reaches before leaving the works, a temperature as low as the lowest it will encounter in the distributing system, there is no possibility of naphthalene being deposited. Unless a plentiful supply of cold water can be had, this condition of temperature is hard to obtain in the works, so the problem becomes how to reduce the naphthalene content to a safe point, when unable to reduce the temperature.

One method of successfully obtaining this result can probably be best described by briefly stating the experiences through which the Los Angeles Gas & Electric Corporation passed.

The water supply of this company was entirely inadequate to reduce the gas to a temperature which would keep large amounts of naphthalene from leaving the works. The average temperature of gas leaving the purifiers was always 80° F., and at times of water shortage was well over 100° F. At all temperatures, according to picric acid tests, the gas was saturated with naphthalene. Cool city water was used in the station meters, so that the gas suffered quite a drop in temperature upon entering them, with the result that the meters became completely blocked with naphthalene in about two weeks. They then had to be shut down and steamed for tweny-four hours, during which time about one hundred pounds of solid naphthalene would melt and run out. Sixteen inch mains leading from the works to the storage holders had to be steamed out at similar intervals. Complaints of stoppages, from consumers, were exceedingly numerous, and at the time of installing the first oil scrubber, July, 1906, had reached over 500 a day.

Every effort was made to reduce the temperature of the gas at the works, and at one time the installation of a refrigerating system was even considered. A small scrubber using 45° Be' distillate as a solvent had been installed two years before and was successful in handling a small volume of gas, but it was expensive in operation. Experiments were made with tar from the works as a solvent, but it was found to be in all cases too highly saturated with naphthalene to be of further use. In some cases the tar actually gave off naphthalene to the gas it was washing. Fuel oil of 16° Be' was tried in an experimental scrubber with results so gratifying that a water tank, twenty feet in diameter by sixty feet high was hurriedly converted into a scrubber, and the fuel oil supply of the plant used to wash the entire gas output. The amount of naphthalene was reduced to about 15 grains per 100 cubic feet in the gas leaving the scrubber, but on account of the great number of stoppages then occurring it was desired to send out gas altogether free from naphthalene. The entire supply of gas oil (19.5° Be') was, therefore, turned through the scrubber, with the result that so long as the gas entered at a temperature not much above 90° F., it went out so clean that a picric acid test run for nine hours showed no precipitate. Whenever gas at the inlet reached a temperature of 95° F., amounts of naphthalene, increasing

with the temperature, passed through the scrubber. This is explained by the rapidly increasing amount of naphthalene carried into the scrubber as the gas grew hotter. The same oil has been used for removing naphthalene, and subsequently in the generators for making gas, at this plant for five years, and so far absolutely no bad effect has been noticed on account of this practice.

The very fact that crude oil would dissolve and remove the vapor of naphthalene from gas, led me to suspect that it would also remove serious amounts of other more abundant and valuable hydrocarbons. Therefore, I made, early in the experimental stage of oil scrubbing, a careful investigation of its effect upon the quality of gas. Tests with Junkers' Calorimeter and a bar photometer failed to show any appreciable loss in calorific or lighting value and gas analysis did not show any change in the percentage of hydrocarbons absorbed by bromine. It is possible that there is an exchange of hydrocarbons between the gas and the crude oil, but whatever the action, there is no detectable change in the commercial quality of the gas treated. Gas saturated at 70° F. contains .01 per cent by volume of naphthalene vapor, or a cubic foot contains .24 grains having a heating value of 0.6 B.t.u. Assuredly the removal of these amounts of naphthalene alone cannot seriously affect the quality of the gas.

The effect of oil scrubbing upon the organic sulphur content of gas was also investigated, and no appreciable results were recorded with the oil being used. It certainly would not do to wash gas with oil containing free sulphuretted hydrogen as found in the oil produced by some wells in the Sherman and Coalinga fields.

Immediately after the installation of oil scrubbing the reduction in naphthalene complaints was slight, if any, and the practical success of the system was severely questioned, even though chemical tests showed it to be doing all that could be desired. No trouble whatever was given by the station meters or large mains from the day that the first oil scrubber was put in use. A considerable decrease in the number of complaints was noticed in about a month, and from then on the number gradually lessened and the complaints came from farther and farther from the works. As late as two years after commencing oil scrubbing, during certain short periods of hot days and cold nights, as many as 100 stoppages were reported in a single day. During the past year complaints of naphthalene have entirely disappeared; not a single case having been reported in several months.

The long time required for the disappearance of trouble is accounted for by the fact that the entire distributing system, including the storage holders, were heavily charged with naphthalene which the clean, warm gas leaving the works readily absorbed, only to deposit farther out when a lower temperature was encountered. Numerous tests were made from time to time showing the cleaning of the system in progress. At an early period clean gas from the works was practically saturated when leaving the storage holders ⅜ of a mile away. Later on the gas did not contain serious amount of naphthalene. It was two or three miles out. The greatest persistence of trouble occurred in the outlying districts where pipes had been longest laid.

The trouble given by gas delivered directly from the high pressure system was always much less than on the low pressure. Some trouble, however, was caused by minute quantities of naphthalene, often a single crystal, clogging the small openings in regulators. Gas which is saturated with naphthalene, compressed to thirty pounds a square inch and subsequently cooled, while still under pressure, to its original temperature, must, on account of the well laws of vapor tension, drop two-thirds of its napthalene. Therefore, naphthalene will be deposited in large quantities when hot gas from a compressor passes into pipes in the cool ground. In our system we found much naphthalene dissolved in an oily condensation deposited in drips within two miles of the compressor station. In this liquid condition it was entirely harmless and easily removed.

It is my opinion that the use of high grade gasoline for the removal of stoppages from service pipes is, in general, ill advised. There can be no doubt that naphthalene is readily soluble in light gasoline and that stoppages are easily and quickly removed and blown back into the main when it is used. The vapor tension of gasoline, particularly of high gravity, is much higher than that of naphthalene, and the gasoline solvent is, therefore soon carried off by passing gas, having a large part of the naphthalene deposited, as before, in the main. If a solvent having a lower vapor tension, say stove distillate, (34° Be') were used, a more permanent solution would be formed, which would have time to run to a drip and be pumped out. Likewise, a low grade petroleum distillate heated to 180° to 200° F. and injected at the highest point is much better than cold gasoline to clear a partially stopped main. Nothing short of live steam applied for a considerable time will clean an entirely stopped main.

As to the form of the oil scrubber itself and its mode of operation in the plant mentioned, scrubbers 20 ft. in diameter by 60 ft. high are used. Gas enters through a 30 in. pipe about 7 feet from the ground and leaves at the top. Layers of two-by-four pine timbers, lying on edge, leaving a two inch gas space, are placed throughout the height of the scrubber. The timbers in successive layers are arranged to form a spiral, so as to thoroughly mix the ascending gas with the descending oil. A 10 x 6 x 12 in. double acting pump is used to raise oil in a three-inch pipe and discharge it through six openings, ⅜ in. in diameter. About four feet of oil is maintained in the bottom of the scrubber, which is used for circulating in connection with enough fresh oil to keep the mixture far below saturation with naphthalene. Of course, as fast as fresh oil is drawn in, old oil goes out into the works lines and is used. A scrubber such as I have described, using about four gallons of fresh oil per minute and enough used oil to keep a pump of the above size, running at a normal speed, is capable of reducing the naphthalene of 10,000,000 cubic feet in twenty-four hours, from 70 grains to 5 grains per 100 cubic feet.

A few words as to the method which I have found most satisfactory for determining the amount of naphthalene in gas, may be of interest. A solution of picric acid is prepared by dissolving with gentle heat 12 grams of the acid in one liter of water. If not clear, the solution should be filtered and then standardized by titrating 20 cubic centimeters with tenth normal caustic potash, using lacmoid indicator. Two hundred cubic centimeters of the solution is placed in an all glass gas washing bottle, and the gas to be tested bubbled through it, and thence into a meter, at a rate not exceeding two cubic feet an hour. After not less than ten, or more than forty cubic feet of gas have passed, the bottle is disconnected and the solution filtered. I have found in our Southern California climate, any special precautions such as warming before filtering quite unnecessary. Twenty cubic centimeters of the filtrate is titrated, as when standardizing the original solution and the number of cubic centimeters of caustic potash required to neutralize the used acid is deducted from the number required by the original solution. The result is multiplied by 197.1 ($= 10 = 1 \times 100 \times 15.4 \times .0128$) and divided by the number of cubic feet of gas tested, which gives the number of grains of naphthalene per 100 cubic feet. It is very important that the gas pass directly into the washing bottle without the intervention of any rubber tubing, as rubber absorbs naphthalene readily. The use of a train of several wash bottles, as recommended by most text books, is unnecessarily tedious for commercial testing.

UNSTABLE HYDROCARBONS IN ILLUMINATING GAS.

BY. E. C. JONES.

Defining the quality of illuminating gas in terms of candle-power served its purpose after a fashion while gas was used almost exclusively for illumination, and when over 90 per cent of all the gas sold, was consumed through open flame tips for lighting, there seemed to be no other way to arrive at a tangible value excepting to measure the light emitted by the burner commonly used to burn the gas. And this value was expressed in terms of candles, with full knowledge that the light of a candle is as inconstant as the moon.

Every generation of thinkers in the gas industry has sought a reliable and unchangeable unit for the measurement of light, but the standard candle with its uniform weight and composition and under normal conditions burning at the rate of 120 grains of its substance each hour, has survived the results of all these efforts.

It is not the purpose of this paper to discuss the wide field of photometry, but to touch on a few points in order to emphasize the importance of some of the experiments with illuminants on which candle-power depends, and to plead for a heat unit standard of value. While the candle is nominally the unit of light measurement, yet to reduce errors the Pontane lamp and other multi-candle power lights are substituted, while in France the Carcel lamp is used, and in Germany the Hefner unit takes the place of the candle. But whatever light is used as a standard the results of the findings are invariably expressed in multiples of the good old unreliable candle.

Enough for the "constant" end of the bar photometer, and now to consider the variable end, or the gas light to be measured. When the gas was very poor, in the early days of gas, the burners were also poor and through successive stages of inventive development the quality of gas was improved, and the burner through which it was transformed into light, was also improved.

The German lava tip Argand burner developed more candle-power than the crude iron "fishtail" and "batswing" burners, but the work of Sugg, produced the Standard Argand burners now in universal use in photometry. These burners are made in a series adapted to the requirements of different kinds of gas, and by ingenious contrivances the proper amount of air is supplied for combustion to gas issuing from openings of the right size in the burner. The different burners also require glass chimneys of different diameters and heights to assist combustion.

The Sugg Argand burner has been accepted as a satisfactory standard for photometric comparison, it having been generally conceded that this burner develops more light measurable as candle-power than any other. The only exception to this, was the application of the Sugg burner to carburetted water gas, when it was found that an open flame tip, of the Bray type, developed more candle-power. Many of the municipal ordinances concerning candle-power provide that the gas shall be tested by a burner best adapted to general use for house illumination, this requirement would be filled by the open flame burner better than by the expensive and complicated Sugg Argand burner, with its glass chimney.

Other factors which affect the art of photometry in its exactness as a science, are the color of the lights compared, and the question of intensity of light, and its diffusion, resulting in the arbitrary adoption by different observers of photometer bars of either sixty or one hundred inches in length. The area of the light emitting flame has much to do with illumination and it is a question if this is fully appreciated by the reflections of the little grease spot, on the Bunsen disc.

The wonderful and revolutionary discoveries by Dr. Carl Auer von Welsbach have changed our aspects of the intrinsic and economic value of gas. Previous to these discoveries the use of gas for cooking, heating, and other industrial purposes had steadily increased, utilizing the best giving qualities of gas, and to a certain extent, ignoring, the highly sensitive portions that constitute its chief value as an illuminant, in fact, the most valuable light giving hydrocarbons often interfere with complete combustion, in appliances designed solely to develop heat from gas.

The advance in the use of gas for heating was accompanied by a wane in the use of gas for lighting; this was caused by many well known reasons, amongst which was the lively competition of electric lighting, which had it not been checked by the incandescent gas light, with its high efficiency and economy, would have obliterated gas from the field of artificial illumination. As it is, however, probably as

[illegible] gas made for passage through [illegible] been passed [illegible] the bar [illegible]

[illegible] of gas stored in a [illegible] holder [illegible] candle-power of [illegible]

[illegible] was [illegible] was heated [illegible]

[illegible] candle-power of the gas [illegible]

[illegible]

[illegible] pipette has been used.

EXPERIMENT A.

Gas [illegible] candle-power (large sample in holder [illegible]

[illegible] = [illegible]

Illuminants No. 1 = [illegible] } [illegible] total illuminants.
Illuminants No. 2 = [illegible]

The gas at 17.9 candle-power was passed through the oil scrubber, and again tested for candle-power, and for illuminants No. 1 (with oil) and illuminants No. 2 with fuming sulphuric acid.

Temp. Oil F.	Candle-power.	Illuminants No. 1.	Illuminants No. 2	Total Illuminants
70° Fah.	4.1	0.0	4.5%	4.5%
80° "	3.1	0.0	4.0%	4.0%
90° "	3.8	0.0	4.4%	4.4%
100° "	2.4	0.0	4.9%	4.9%
110° "	4.3	0.0	4.5%	4.5%
120° "	2.6	0.0	3.8%	3.8%
130° "	3.5	0.0	4.7%	4.7%
140° "	4.0	0.0	4.2%	4.2%
150° "	6.3	0.0	4.7%	4.7%
160° "	5.1	0.0	4.9%	4.9%

The maximum effect on the gas was with oil at 100 degrees F. when one passage through the scrubber reduced the candle-power from 17.9 candles to 2.4 candles and the hydrocarbons were reduced from 6.3 per cent to 4.9 per cent, in other words reducing the hydrocarbons 1.4 per cent by oil scrubbing, reduced the candle-power 15.5 candles.

EXPERIMENT B

Oil Gas and Lamp Black Water Gas 19.8 candle-power.
Carbonic Acid Gas = 3.0%
Illuminants No. 2 = 6.9% } 8.4% total illuminants
Illuminants No. 1 = 1.5% }

This test was in every way similar to Experiment A, excepting the gas used had higher initial candle-power and illuminants. The gas was scrubbed with crude oil 16.5° Beaume.

Temp. Oil F.	Candle-power.	Illuminants No. 1	Illuminants No. 2	Total Illuminants
70° Fah.	2.9	0.0	6.0%	6.0%
80° "	2.6	0.0	6.0%	6.0%
90° "	2.9	0.0	6.2%	6.2%
100° "	2.3	0.0	6.2%	6.2%
110° "	2.5	0.0	6.4%	6.4%
120° "	2.8	0.0	6.4%	6.4%
130° "	3.2	0.0	6.6%	6.6%
140° "	3.8	0.0	6.4%	6.4%
150° "	4.1	0.0	6.0%	6.0%
160° "	4.0	0.0	6.4%	6.4%

In this experiment the maximum effect was also with oil of 100° F. when the oil scrubbing reduced the illuminant from 8.4 per cent to 6.2 per cent and the candle-power from 19.8 candles to 2.3 candles, thus showing that 17.5 candles of illuminating value was produced by 2.2 per cent of the volume of the gas or by 26 per cent of the illuminants contained in the original sample.

EXPERIMENT C.

Oil Gas = 19.9 candle-power.
Carbonic Acid Gas = 2.2%
Illuminants No. 1 = 2.8% } 7.0% total illuminants.
Illuminants No. 2 = 4.2% }

In this experiment the gas was scrubbed with a distillate of 24° Beaume.

Temp. Oil F.	Candle-power.	Illuminants No. 1	Illuminants No. 2	Total Illuminants
70° Fah.	3.6	0.0%	5.2%	5.2%
80° "	2.9	1.3%	3.7%	5.0%
90° "	2.3	1.0%	3.8%	4.8%
100° "	2.1	0.0%	5.0%	5.0%
110° "	2.1	0.4%	4.2%	4.6%
120° "	3.4	1.2%	4.3%	5.5%
130° "	3.4	1.2%	4.3%	5.5%

The greatest reduction in candle-power in this experiment was with oil at 100° and 110° F. when the candle-power was reduced from 19.9 to 2.1 candles, and at 100° F. the illuminants were reduced from 7.0 per cent to 5.0 per cent, or a loss of 12.8 candles by a reduction of 2 per cent of illuminants. These experiments all demonstrate the instability of a portion of the hydrocarbons, and the large proportion of the total candle-power produced by a small amount of illuminants.

The illuminants that are removable by oil contain the cause of all naphthalene deposits, and the bulk of condensation other than water in street main drips. They are the seat of candle-power fluctuations and are affected by changes in gas humidity, or water vapor content in the gas. They are also easily removable by compression. A glance at the tables of candle-power would impress an observer that the scrubbing by oil had rendered the gas useless and unsalable, yet the calorific value of the gas remains practically undisturbed. The loss in candle-power is not accompanied by any proportional or even significant loss in B.t.u. During the progress of the experiments, it was noticed that after repeated use of the same oil for scrubbing, the oil becomes spent, or saturated by repeated exposure to hydrocarbons and it was necessary to use fresh oil for each test. To determine the capacity of a given oil to absorb hydrocarbons the following experiment was made:

A small oil scrubber was constructed and a special sensitive balance was used for weighing the apparatus and its contained oil, and the increment due to the absorbed hydrocarbons.

The apparatus weighed..	1740.2 grammes
The oil used weighed...	118.0 grammes = 4.165 oz.
Total weight of apparatus and oil	1858.2 grammes

The oil used was California crude petroleum of 14.8° Beaume at 60° F., .9682 specific gravity and weighing 8.055 pounds per gallon. Oil gas of 20.3 candle-power was passed through the scrubber at a rate of five cubic feet an hour for two hours and then at the rate of ten cubic feet an hour for a period of 1 hour and 30 minutes.

The candle-power was taken by Bunsen Bar tests, and the lessened decrease in candle-power shows the progress of the saturation of the oil by hydrocarbons and finally its failure to absorb any more of the illuminants.

OIL GAS USED 20.3 CANDLE POWER.

Time	Cu. ft. of gas passed through scrubber	Candle-power after scrubbing	Lessened decrease in Candle-power
12.00 M	Start	7.2 candles	
1.00 P. M	5 cu. ft.	16.5 "	9.3 candles
2.00 "	10 "	18.7 "	2.2 "
2.30 "	15 "	20.0 "	1.3 "
3.00 "	20 "	20.6 "	0.6 "
3.30 "	25 "	20.7 "	0.1 "

After scrubbing, the apparatus and oil weighed 1861.00 grammes, a gain of 2.8 grammes, equal to 2:37 per cent in weight of hydrocarbons absorbed from 25 cu. ft. of gas.

The oil after having been used for scrubbing was 16.5° Beaume, an increase of 1.7° Beaume.

The following analyses of two samples of gas taken simultaneously, show that oil removes nothing but hydrocarbons of the illuminant content of the gas.

Carbonic Acid Gas	3.0		3.0	
Illuminants	7.7	No. 1	1.6	7.7*
		No. 2	6.1	
Oxygen	0.2		0.2	
Carbonic Oxide	10.1		10.1	
Hydrogen	41.7		41.7	
Marsh Gas	31.6		31.6	
Nitrogen	5.7		5.7	
	100.0		100.0	

*Note. Illuminants No. 1 were removed by absorption in oil. Illuminants No. 2 were removed by absorption in fuming sulphuric acid.
Candle-power, 19.0.
British thermal units, 671.
Specific gravity, .408.

It is possible that a uniform system of gas making, using oil of even quality, through ranges of temperatures comparatively constant, may produce gas of which the candle-power and heat units appear to bear a fixed relationship to each other. This relationship is misleading, however, as heat units and candle-power are not entirely dependent, one upon the other, any more than is the percentage of illuminants contained in the gas a safe measure of candle-power.

This is well illustrated by the following experiments. Oil gas of 19.6 candle-power and containing 7.7 per cent of heavy hydrocarbons was analyzed to determine its constituents. The benzine was removed with nickel ammonium cyanide, and the other heavy hydrocarbons with fuming sulphuric acid, another sample of the same gas was analyzed, using the oil pipette, and then the fuming sulphuric acid. And finally another sample of the same gas was passed through the oil scrubber and then analyzed.

	Original gas.	Gas after oil scrubbing.
Candle-power	19.6 candles	4.9 candles
B.t.u. (by Junkers' Calorimeter)	657	627
B.t.u. (by analysis)	715	689
Specific gravity	.493	.489

ANALYSIS.

	Original gas	Original gas using oil pipette	Gas after scrubbing with oil
CO_2	2.6%	2.6%	2.6%
C_6H_6	1.0	0.0	0.0
C_nH_{2n} (oil pipette)		1.7	0.0
C_nH_{2n} (fuming sulphuric acid)	6.7	6.1	6.0
O_2	0.3	0.2	0.4
CO	10.0	10.2	10.3
H_2	37.5		37.7
CH_4	37.1		37.7
N_2	4.8		5.3
	100.0		100.0

The reduction in candle-power due to passing the gas through the oil scrubber was 14.7 candles, or 75 per cent. The reduction in heating value by Calorimeter, was 30 B.t.u. or 4.6 per cent and by analysis was 26 B.t.u. or 3.6 per cent. The experiment shows that 75 per cent of the candle-power of the gas was produced by 1.7 per cent of illuminants, and that this great reduction in candle-power only affected the heating value 4.6 per cent.

Some experiments in the making of coal gas, in 1901, were made from bituminous coal, by passing the gas through a second chamber containing highly heated coke, with the result that the hydrocarbons in the gas were entirely broken down and the finished gas was non-luminous, yet it had the characteristics of coal gas, excepting hydrocarbons, and contained about 700 B.t.u. per cubic foot. Some of the unstable hydrocarbons in illuminating gas are theoretically very high in heat units as for instance:

Naphthalene	C_1CH_8	6176 B.t.u. per cu. ft.
Benzine	C_6H_6	4010 " " "
Propylene	C_3H_6	2509 " " "
Ethane	C_2H_6	1858 " " "
Ethylene	C_2H_4	1673 " " "
Acetylene	C_2H_2	1555* " " "

The perfect and complete combustion of these illuminants should develop the theoretical high candle-power, and heating effect, but it is impossible under ordinary conditions to provide a perfect admixture of air to a burner, and the result is a smoky flame, or loss of heat.

*Stillman's Engineering Chemistry.

The Bunsen burner attachment for consuming gas in the calorimeters of the Junkers' type will not develop the theoretical heat units of any of these hydrocarbons, if burner undiluted. Acetylene, one of the illuminants of our city gas, and now commonly used as an illuminant for automobiles, has a calculated heating value of 1555 B.t.u. per cubic foot, and yet this gas cannot be burned with an air mixture in a Junkers' calorimeter, and an imperfect test of this gas would not develop more than half of its calculated heat units. This being true of the richer hydrocarbons burned separately, may it not be true also of different mixtures of these hydrocarbons with diluents, burned through a Bunsen burner of a calorimeter, intended for testing gases of more uniform composition, and apparently readily burned in that type of burner. The fact that the results of calculating heat units from analyses are invariably higher than those obtained by calorimeters of the Junkers' type seems to prove this assertion.

The adoption of a heat unit standard will not permit the gas manufacturer to make an inferior gas, nor to vitiate the gas with inert, or impure gases. It will simply enable him to make a more stable gas which will withstand the shocks of changes of temperature, and humidity, and the effect of friction in pipes and fittings. To fulfill the requirements of a standard of 500 B.t.u. per cubic foot, the gas would have to contain a large percentage of marsh gas, or other stable hydrocarbons. Hydrogen alone would not meet this requirement, for although it is an exceedingly hot gas when considered by weight, it is also a very light gas and contains but 344 B.t.u. per cubic foot. Carbonic oxide has a value of 343 B.t.u. per cubic foot, and either alone, or mixed with hydrogen would not meet the above requirements.

Where water gas is now used as an enricher of coal gas, in the event of the adoption of a heat unit standard, the water gas may be used as a diluent heating gas, consisting mainly of hydrogen, marsh gas, carbonic oxide, and a small amount of stable illuminants. This gas would help to dilute, sustain and consume the illuminants of coal gas.

Some of the California natural gas of the Midway field, now being supplied to Bakersfield, contains as much as 99.1 per cent of marsh gas and has a heating value of 1063 B.t.u. per cubic foot. This is a good heating gas, and may be used for illumination in incandescent burners, yet the gas has little, if any, candle-power.

Calorimetry is more nearly an exact science than photometry, because the total heat of combustion of gas may be measured by accurate thermometers, or the theoretical heat units may be quickly calculated from analysis. There are also many ways of burning the gas with oxygen, (notably Hempel's) whereby the heating value of the gas may be determined without any practical error.

In changing from the candle-power to the heat unit standard, all of the errors which enter into photometry are eliminated, and not the least of these is the personal error of the observer, sometimes amounting to as much as ten per cent. For after all of the refinements of photometric testing have been prac-

ticed, the final determination of the candle-power must rest upon the visual impression of light upon the human retina, and there are no instruments for measuring the fallibility of human judgment.

Gas of 500 B.t.u. to the cubic foot, would be a satisfactory gas for the use of the consumer, it may be non-luminous, but would probably be a gas of low candle-power, and it would not in any sense be a poor gas, nor could it be carelessly made. Such gas would stimulate new uses for gas, and these new uses would increase the production, thus resulting in economies in manufacture, redounding to the benefit of the manufacture, as well as the consumer.

RATES FOR GAS SERVICE.[1]

BY C. L. CORY.

Working Capital.

A gas plant and system in operation must have working capital as well as fixed capital. Stores and supplies which are included in the fixed capital do not represent all of the working capital such plants require. There must be available a reasonable cash balance and other current allowances in order to operate economically and effectively. Just what sum represents a fair amount for working capital is nearly always a matter of judgment. From the amount of working capital usually carried by such companies and from the amount that is required by other similar public utility corporations, it appears that as an average for the year a sum equalling the accounts receivable and cash on hand less the accounts payable and consumers advance payments is a reasonable allowance. The cash on hand, however, should be considered as that which is ordinarily required for the operation of the plant and the conduct of the business, including contingencies and emergencies, and should not include the capital or ready cash necessary for the construction of extensions or enlargement of the plant, or balances resulting from the sale of bonds or stock or in any case exceed the amount normally needed and used by the company as an operating property.

Such an inventory coupled with what might be called the inventory costs serves to obtain the detailed and segregated costs of the various elements going to make up the physical property of the plant. In addition in order to estimate the total valuation it is necessary to ascertain as nearly as may be the time required for construction in order that interest upon the investment during the construction period may be estimated. The cost of engineering, supervision, fire and casualty insurance, administration, legal expenses and other factors must also be obtained, preferably from the actual working conditions during which recent construction work was carried out.

Taken together the cost of reproduction new of the physical plant is usually considered to be the sum of the elements above enumerated. The cost of reproduction new has been variously interpreted, sometimes erroneously, especially when it has been held to mean a system identical with the one the valuation of which is under consideration. Properly, it should be understood as a plant of similar character and equal efficiency. The age of the system will have much to do in indicating the fairness with which the cost of reproduction new is considered.

[1]Continued from issue of Sept. 23, 1911.

It will depend upon conditions as to whether the cost of production new and the original cost very materially. One of the principal differences which will be found will be in the size and capacity and number of units in the two cases. Gas plants are probably never built in a single year, nor used exactly as they were originally constructed for a number of years. The original cost will probably properly cover the plants as installed with small units, while the cost of reproduction new may be considered to cover only the cost of a smaller number of much larger units having the same aggregate capacity. Especially would this difference arise in connection with the distribution system, both mains and services. Originally one single main on one side of the street of comparatively small size may have been adequate to provide gas service in that particular vicinity. Later on it became necessary to lay an additional gas main many times larger than the original and as is often the case this later main is laid upon the opposite side of the street, resulting in the cutting of all services leading to property on the side of the street where the new main is laid and the connection of those services into the new main, instead of the old. As viewed from present requirements, one gas main alone might be considered in obtaining the cost of reproduction new, while the actual cost would necessarily be greater.

Depreciation in Its Relation to Valuation.

While the original cost as well as the cost of reproduction new are ordinarily of the greatest importance in determining the proper valuation upon which earnings should be based, there is what is often called the present or existing value, or cost of reproduction new less depreciation, which must be given consideration in determining the valuation in question. Especially is this the case in plants the rates for gas service from which have been ample to cover operating expenses, including depreciation, and a fair amount for interest and profits, but the amount collected for depreciation has not been used as it should be and set aside for replacing portions of the plant discarded because of their becoming obsolete, inadequate or worn out, but on the contrary has been distributed to the stockholders in the shape of dividends.

Depreciation should be considered as the amount that must be regularly set aside to cover all portions of the plant that are discarded because of wear and tear, inadequacy, obsolescence and general unavoidable decay. It is an operating expense and should be borne by the customers through the rate paid by them for the service rendered by the utility. But as it is paid by the customers it must be set aside by the company and used when needed for the renewal of worn out and useless portions of the entire system, and under no circumstances should the cost of such renewals be made an additional charge to the capital or construction account except when the replaced equipment is of greater capacity than that which is taken out. Care must also be taken that the operating charge properly known as depreciation shall not be used for ordinary maintenance and repair. Actual

additions and extensions to plant which should be charged to the construction or capital account, replacement of equipment set aside as a result of depreciation, and ordinary repair and maintenance costs, must all three be most carefully separated and completely segregated in the engineering records as well as the financial accounts.

If construction, depreciation, repair and maintenance accounts are not so considered and depreciation is borne by the customers as a result of being included in the operating expense, and such depreciation fund is not used to keep the plant in its proper condition, but is paid in dividends to the stockholders, it is practically equivalent to the payment of dividends out of capital. Rates of service should be such as to include a reasonable charge for depreciation, and if the rates are such as to do this and the amount necessary to cover depreciation is not used as it should be, it cannot mean anything but that the money, either in surplus or dividends is going to the stockholders instead of being used for the purpose intended.

An allowance for depreciation obligates the company to use of this money in keeping the plant in thorough operating condition, and if it is not so used but is turned over to the stockholders, it simply means that a part of their capital is being returned to them, thereby reducing the investment in the plant. If this is the case, as a matter of fact the investment is so reduced and there should be corresponding reduction made in the actual investment presumably represented by the original or cost of reproduction new. In such instances, if the owners of the property, instead of keeping up the plant as they should by the proper use of the annual depreciation charge, have appropriated for their own use the money contributed by their customers, the annual depreciation should each year be deducted from the valuation of the plant which might otherwise be obtained.

Depreciation, like interest, continues constantly and is always present. Every part of the physical property of any system exclusive of the land begins to depreciate when the plant is completed and ready for operation; therefore, the depreciation charge should be constant. It of course may be that such depreciation covering a number of years may be arrived at as an average for a long period, and it will not be necessary to expend the average each year. This is of minor importance, however, providing the methods by which the depreciation charges are obtained are sound and reasonable.

Two methods are in common use for determining depreciation. The first is known as the straight line method, which involves determining the probable ultimate life of each element of the system, consideration also being given to the value of the discarded element as junk at the end of the period. In the straight line method it is assumed that during the entire life of each element of the plant the depreciation is uniform, which of course is not ordinarily the case as the rate of depreciation of a plant as a whole is much more rapid during the latter part of its life than during the first years of its use. Fairness to customers, however, in the different years, as well as safety to investors, indicates clearly the wisdom and correctness in considering the depreciation uniform throughout the entire life of each portion of the plant.

The second method of determining depreciation is upon the assumption that each year an amount is to be set aside and invested at compound interest so that this amount plus interest will be available to cover the cost of the replacement needed at the end of the period when the device or element is discarded, and replacement necessary. The so-called rates of depreciation will naturally be less in the latter method than in the former, since it is assumed that the depreciation fund will earn interest from the end of the first year or even shorter period. If we consider the life of some portions of a plant to be between twenty and thirty years, with the latter method it is necessary for us to in advance assume an interest rate which will continue during this entire period and this is an assumption which, judged by the last twenty-five year period, is hardly justifiable.

It may very properly be said that neither method exactly corresponds to actual experience. At the same time the rate of depreciation is something that must be carefully estimated for each individual plant and the data required compiled from the best information obtainable from those who have been in charge of construction and operation preferably for a number of years. If new devices are constantly being perfected and introduced rates of depreciation will be high due to the fact that older apparatus will become obsolete and inadequate at an early date. On the other hand, if the different portions of the plant are not subject to change as a result of improved or modified methods or distribution, rates of depreciation will be low, providing, of course, that wear and tear and ordinary deterioration are not severe with a reasonable expenditure for ordinary replacement and maintenance.

Intangible Elements of Value.

In determining the proper valuation, therefore, the original cost, cost of reproduction new, present value as affected by depreciation should all be taken into consideration. They are not the only elements, however, although they are usually the most readily determined. One element of value often suggested is that of "good will." The good will of a business is an asset that cannot be ignored in determining the valuation of a property, provided the element of good will is inherent in the business of a public service corporation which may have a practical monopoly. One of the most comprehensive and generally accepted definitions of good will is by Judge Story:

"Good will may properly enough be described to be the advantage or benefit which is acquired by an establishment, beyond the mere value of the capital stock, funds, or property employed therein in consequence of the general public patronage and encouragement which it receives from constant or habitual customers on account of its local position or common celebrity or reputation for skill, affluence, punctuality, or from other accidental circumstances or necessities, or even from ancient partialities or prejudices."

Judge Hough must have had this definition of good will in mind in the case of Consolidated Gas Company vs. The City of New York, in which he says:

"There is nothing in the nature of the business enabling it to acquire good will in the property sense or indeed in any other. It is required by law to furnish gas to all demanding

it within a certain distance of the mains: and it owns the mains, service pipes and meters. What induces a customer to remain with this company, its successor or vendee? Nothing that I can imagine, except a desire to avoid the nuisance of street digging in front of his house; a digging, however, entailing no expense upon him. Yet even this nuisance is in all human probability impossible of occurrence because of the beneficially monopolistic character of defendant's present occupancy of the streets of this city * * *. Finally, this claim of good will seems to forget that for many years the price of distribution of complainant's gas has been regulated by law. A citizen is entitled to have a clean street before his house because he pays taxes, inter alis, for that purpose. He is much more entitled to have complainant's gas in his house because the company must give it to him if he pays for it. I think it apparent that the conceivable good will of a gas company in this city is about equal to that of the street cleaning department of the municipal government."

The public service corporation operating where competition exists may have an element of good will in its valuation, but it is certainly of little if any consequence where the public under any circumstances must obtain its service, if at all, from a single corporation.

In a somewhat similar manner may the assumed value of franchises be considered in determining the valuation of the property of a public service corporation. Based upon court decisions, the principal element in the value of a franchise is the earning capacity of the property of the corporation in connection with which a franchise is necessary. Viewed from this standpoint, since the earnings must be directly dependent upon the rates charged for service, it is evident that to include the value of a franchise as an element in determining rates developes an almost impossible situation. A franchise which is not exclusive can have no real value from any standpoint and is in reality little more than a permit to carry on the business and to do necessary work upon public property. As an element of value, even in the sale or transfer of the property, it is questionable whether such a franchise would be given serious consideration. If, however, a franchise is exclusive and is owned by a company, it may be considered of value and would be rightfully considered a part of the entire system if the business were sold. On this assumption it is proper to consider a franchise as a part of the taxable property of the company. On the other hand, while there may be some cases where the valuation of a property may rightfully include a certain sum as the value of the franchise, yet when this value must depend upon the rates for which service is rendered, it is difficult to see how it should be considered as a part of such valuation.

There is an element of value that must be taken into consideration in determining the valuation of a property and which is sometimes referred to as "Going Value." This is sometimes covered by an allowance usually in percentage to cover the difference between the cost of the physical property and the value of the completed system in operation providing service to its customers and possessing numerous valuable contracts for giving service in the future. Going value is of an intangible character and may be estimated in some instances by estimating the cost of developing the business which the company enjoys at any particular time. The data naturally is rarely obtainable to indicate the money actually spent by the company to obtain its business, since in recent years the period of time during which public service corporations have been ready for operation and yet not actually engaged in providing service, approximately at least up to their normal capacity, has usually not exceeded one or two years. When the earnings of a public service corporation have not been sufficient to meet reasonable expenditures for the development of its business and to cover operating expenses, depreciation and a reasonable return on the investment, the losses incurred in building up the business must be considered as one of the elements to be included in appraising a plant for the purpose of determining the proper rates for service.

Probably the most concise statement in this connection is from the decision of Justice Brewer in a most noteworthy decision in the case of the National Water Works Company vs. Kansas City in connection with the valuation of a waterworks which had been taken by the municipality:

"The original cost of the construction cannot control, for 'original cost' and 'present value' are not equivalent terms. Nor would the mere cost of reproducing the waterworks plant be a fair cost because that does not take into account the value which flows from the established connections between the pipes and the buildings of the city. It is obvious that the mere cost of purchasing the land, constructing the buildings, putting in the machinery and laying the pipes in the streets—in other words, the cost of reproduction—does not give the value of the property as it is to-day. A completed system of waterworks such as the company has, without a single connection between the pipes in the streets and the buildings of the city would be a property of much less value than that system connected, as it is, with so many buildings and earning, in consequence thereof the money which it does earn. The fact that it is a system in operation, not only with a capacity to supply the city, but actually supplying many buildings in the city—not only with a capacity to earn, but actually earning—makes it true that 'the fair and equitable value' is something in excess of the cost of reproduction."

In general it may be said that the courts have with few exceptions held that going value is an important and valuable consideration in determining a fair valuation for the property of a public service corporation devoted to public service. The difficulty, however is in obtaining a fair and proper figure in any given case. Competition may at any time seriously affect any estimate which may be made of the probable value of a going concern as contrasted with the physical plant without customers or contracts. It is probably most satisfactory to treat this matter primarily from the standpoint of the excess value of the completed system in operation over and above the original cost, cost of reproduction new, or cost of reproduction less depreciation, of the physical plant.

If this is done, however, such excess value of the completed operating system must be considered entirely separate from a percentage which may properly be considered as approximately the contractor's profit who undertakes to design, build and supervise the complete construction of an entire system, turning it over ready for operation to its owners.

The true value of a thing has been defined as the price upon which a purchaser and a seller mutually agree and at which figure an actual transaction takes place. If an existing plant and system were to be purchased and the owners were willing to sell at all, they would surely take into consideration what it would cost the purchaser to duplicate, not only the physical plant, but obtain all of the business enjoyed by them, and the prospective purchasers would surely consider what it would cost them independently to install a plant of equal general efficiency and usefulness, including the business developed and under control of the prospective sellers. In the long run.

the true value must be the capitalization of an assured income. A certain portion of this value is represented by tangible property and the remainder, if there be any, must be regarded as primarily traceable to the earning power of the business.

Gross Revenue, Cost of Operation and Quantity of Gas Manufactured and Sold.

Gas being a commodity, it is manufactured, distributed and sold to those who use it. As manufactured and sold it is divided into units which are usually 1000 cubic feet. The operating expenses may be properly divided into manufacturing, including fuel, distribution, general expenses, taxes and licenses and depreciation. For any period the unit cost may in a general way be obtained by dividing the total expense by the total quantity sold and the average cost per 1000 cubic feet is thereby obtained. Similarly, the unit cost for fuel and other station costs, for distribution, taxes and licenses, depreciation and general expenses, may also be determined. It is of importance also to know the relation between the total gas made and delivered to the holders and the quantity actually sold as per customers' meters. In this manner definite data is obtained for the leakage and the reduction in volume of the gas as measured by the station meters and by customers' meters.

The operating expenses can be definitely divided under two heads, fixed and variable. The fixed costs should include all expenses that are independent of the quantity of gas made but which remain practically constant whether the plant is operated at or near its full output, or at a fraction of this. Variable expenses include those costs that vary with the output and may be considered as of little consequence if gas is not made. Naturally, these two classes of costs are dependent and may vary widely.

It is not always possible to make a definite segregation of these fixed and variable expenses, but when necessary, approximate subdivisions may be made of expenditures involving both. The cost of manufacture per 1000 cubic feet depends largely upon the total amount of gas made, decreasing as the volume of production increases and increasing as the quantity made decreases, and a slight reduction in the sales will materially increase the cost of manufacture per 1000 cubic feet. The greater the sales the smaller is the cost of manufacture, but not in the same proportion for the total cost of service, when we include the distribution to customers' meters, and it is therefore of the greatest importance in discussing the rates for which gas may be sold to clearly distinguish between the cost of gas in the holder and when delivered to the customers' premises.

In general, it may be said that very large consumers involve a smaller cost per 1000 cubic feet than small consumers. The question naturally arises, should this difference in the cost of service to various classes of consumers be taken into consideration in determining the proper rates for service? The same rate for all is a term that is often much more beautiful in the abstract than when absolutely applied. Sometimes such a policy, when it means the same rate for all regardless of both cost and the effect upon the growth of the business, is a violation of sound business principles and decidedly against public policy. Often, uniform rates for a very large territory with the same class of customers may fulfill all requirements, but it does not follow that the best interests of all concerned are conserved where, in deciding upon a rate, it is made uniform for every customer. Very closely related to the fixed and variable expenses are capacity and output expenses, and in some respects they more clearly define the costs involved in the two classes of expenditures. There is a term known as "Consumer's charge" which may ordinarily be included as a part of the fixed costs of operation, and such expenses are directly proportional to the number of consumers taking service.

These considerations usually lead to the establishment of what is known as minimum rates or a minimum bill, which should be high enough to cover the cost to the company of the consumer independent of the quantity of gas which may be delivered to and used by him. Many times the actual consumption of gas for small customers is not a great factor in the cost of rendering service and from this standpoint the establishment of minimum rates would seem to be sound and thoroughly justifiable.

While no rates should be greater than the value of the service rendered, it is not necessarily equitable to charge the same rates to all regardless of the actual cost, and, as the cost of manufacture per 1000 cubic feet depends very largely upon the magnitude of the output, such a policy might not only tend to discourage large consumption but to actually increase the cost to small consumers. It may even happen that large quantities of gas should be sold at even less than enough to yield the regular rate of return rather than these quantities should not be sold at all.

This phase of the situation is often entirely neglected, not only by gas companies, but by those responsible for the adjustment of rates on an equitable basis. Failure to consider such opportunities often results in losses of great magnitude and thereby results in increased cost to all consumers. A wise and far-seeing management having all the information available can usually treat such matters most effectively by taking into consideration the location of such large customers and the character and magnitude of service required.

In this connection it is of interest to discuss the advisability of charging a higher rate for gas when used for lighting purposes than when used for heating and cooking. As a matter of fact by far the largest part of the consumption of gas is for purposes other than lighting, and this probably accounts for the fact that the rates for the two classes of service differ. In addition there is of course the fact that the use of gas for lighting concentrates the maximum demand somewhat similar to, although of less magnitude than, the use of electricity for lighting. Gas is stored in the holder with little additional cost as compared with the storage of electricity, so that the peake load character of the demand is decidedly of smaller consequence, as regards the maximum capacity of the plant, than in the generation and consumption of electrical energy. Whether use for lighting or fuel on the customers' premises the gas is used in the same way and from the same service pipes, and unless there is a very

great difference in the magnitude of consumption in the two cases it is difficult to see where lies the difference in the cost of service in the two instances.

Rate of Return on Investment.

What is an adequate return on the investment for a public utility corporation is a question that has been given the greatest consideration, not only by the courts of the country, but by Federal, State, Municipal and other commissions. In the U. S. Supreme Court decision in the Consolidated Gas Case of New York, it is stated that:

> "There is no particular rate of compensation which must in all cases and in all parts of the country be regarded as sufficient for capital invested in business enterprises. Such compensation must depend greatly upon circumstances and locality; among other things the amount of risk in the business is a most important factor as well as the locality where the business is conducted and the rate expected and usually realized there upon investments of a somewhat similar nature with regard to the risk attending them."

In considering such a matter it is evident that under present industrial conditions the best interests of society as a whole are subserved when the share of each factor of production is high enough to cause a free and natural distribution of capital and business ability as well as labor into all utilities. When wages and the returns on investment are not high enough to be attractive then in such a utility there must be a decline. No utility will be furnished unless the factors making such a utility attractive are present. Wages must be high enough to attract competent workmen, salaries sufficient to engage successful superintendents and managers, interest on the capital legitimately invested must be earned, and, in general, the return must be high enough to induce investors to assume all risks and responsibilities that are involved in their operation. From this it naturally follows that the rate fixed for service rendered by public utility corporations must in the long run be high enough to attract all of the elements necessary for the production of that service, taking into consideration the wages to be paid, the cost of superintendence and management, the interest on the investment and a reward for the risk and responsibility entailed.

Unfortunately, however, many who have been most active in the development of public utility corporations in recent years have been interested therein primarily from the speculative standpoint rather than as legitimate investors. Speculation necessarily involves risk. An investment is generally considered reasonably safe. A high rate of return rarely compensates when there is a danger of losing a part or all of the principal. Customers of a public service corporation have a right to demand that the rates they pay for service shall be only adequate to give a proper return upon the necessary investment required, and not so high as to make the return, upon a reasonably safe investment, of the magnitude usually demanded in a pure and unadultered speculative venture.

The tendency toward legislation affecting public utilities, the creation of wise and powerful commissions and the enactment of numerous laws not only regulating but actually protecting public service corporations constitute a definite reduction in the risks and hazards formerly existing in many instances.

In public utilities capital cannot be turned over as frequently as in commercial enterprises, due to the relatively large proportion of the fixed investment. Legislative regulation of public utilities through commissions may in some respects be detrimental to financial operators who endeavor to evade their obligations under the common law and who try to profit by the manipulation of capital rather than through legitimate, effective and economical operation of their plants. Such regulation, however, cannot possibly result in permanent injury to the great majority of investors and to the utilities themselves if honestly applied and administered with ordinary care. An investment along the lines of and in the spirit of such laws as those which have been upheld by the courts assures, in every case, a reasonable return on a fair valuation of the plant.

While public utilities are subject to many conditions that tend to increase the risks under which their business is carried on, they are also afforded a great deal of protection that is of the greatest value to investors. Many are natural monopolies engaged in furnishing service that has practically become a necessity and for which, at least at the present time, there are no effective substitutes. An investment in a public utility corporation wisely directed, while involving a greater risk than if the same money was placed in good mortgages, should not involve hazards equal to investments in ordinary competitive enterprises.

The profits of a business consists of the balance between the sum of expenses and the total income of the business. It is the difference between the sum representing the operating expenses, which includes rent, salaries and wages, fuel, taxes, interest, depreciation, and the total gross revenue. This difference is the last share of the total income and unlike all the other shares is not fixed. It simply consists of what is left after all other claims have been completely satified. Salaries, wages, rents and interest are usually fixed at a certain amount per annum in advance and are paid out of the gross receipts. The amount left after these shares have been satisfied belongs to the owner and represents his share of the profits of the business. Interest and profits, notwithstanding the indeterminate quality of the latter, are usually measured upon the same basis and are included in what is generally known as the adequate return on the investment.

The difference between the gross revenue and the aggregate of the legitimate operating expenses for a single year is the sum usually considered as the net revenue or return upon the investment. As the gross revenue and the operating expenses are for many reasons subject to wide variations, it is manifestly unsafe to determine rates upon a single year's business. A most valuable method is to consider the gross and net return per dollar invested for a number of years of operation. By doing this the additional investment in the plant from year to year as well as the growth of the business, both from the standpoint of gross revenue and operating expenses, is obtained. In fact, many important conditions affecting the company are brought to light in such an analysis.

The value of ascertaining how much a dollar earns, both gross and net, is due to the important differences between public service corporation and ordinary commercial enterprises. In most private un-

dertakings the operating expenses can usually be greatly reduced or even practically eliminated if for any reason the gross receipts are reduced so as to make the business unprofitable. But this cannot be done in the case of public service corporations, who must under the law provide service to all within the territory covered by the distribution system provided who request it. While the investment in the private enterprise may be greatly restricted or even withdrawn, such is not the case with a public service corporation. The relatively large investment in plant, equipment and other property of the public service corporation means that the interest and other fixed charges go on at about the same rate whether the plant is operated and its output sold or not. As a result, the public service corporation is compelled under certain adverse conditions to keep its plant in operation even if the actual operating expenses are greater than the gross receipts.

A complete investigation of all conditions existing for a number of years is therefore of much greater value than confining the data upon which rates are fixed to a single year's business. The public service corporation should not be a free agent to do absolutely as it pleases, and on account of this restriction certain reasonable protection is desirable for all concerned. Free and unrestricted competition between private enterprises may be of the greatest benefit to the public. Experience shows, however, that this is not the case with public service corporations where the commodity furnished by them is a necessity and the character of the business such as to be a natural monopoly. Competition in such cases inevitably results in a bitter struggle for supremacy and rates so low as to be inadequate to maintain the proper quality of service and yield a return sufficient to make extensions commensurate with the growth of the community. Two or more distinct and separate corporations providing the same public commodity are not likely to remain separate very long. Sooner or later it will be self-evident that the service rendered by them independently can be more cheaply, effectively and in a better manner provided by a single operating system under one management. As a result it is an invariable rule that competition which is often thought to be preventive of excessive rates becomes ultimately the direct cause of what is relatively extortionate rates of service, when compared with what the rates should be if destructive and temporary competition is prevented and the rates equitably fixed under proper control by a wise commission.

Again, a modification of rates at frequent intervals is undesirable, as it renders unstable and therefore the more hazardous the entire business of rendering service. Everything of every character tending to eliminate uncertainties and general risks on the one hand, and which provides protection and wise regulation on the other, definitely increases the security of the investment, the required return upon which is thereby reduced, the general stability of the enterprise is materially improved, restulting not only in reduced rates but improved quality of service.

Conversely, the rate of return on the investment and consequently the rates of service must be correspondingly high as long as unrestricted competition threatens, and extraordinary risks involving a possible loss of a large fraction of the investment confronts, those interested in the progress and development of public service corporations in general.

In the end, all costs of every character, such as litigation and other expenses, incident to the establishing of rates, whether paid out of public funds or by the public service corporations, come out of the customers' pockets, as taxpayers in one instance and as consumers forced to pay the company for service in the other. The constant danger to the company of having its investment as well as its gross revenue seriously impaired due to the fixing of rates upon other than a sound and equitable basis involves that much extra hazard in conducting its business, necessarily requires an increased return upon the investment on account of such menace, and in turn will ultimately result in rates higher than they should be.

Members in Attendance at the 19th Convention of the Pacific Coast Gas Association, Sept. 19, 20, 21, 1911, Oakland, Cal.

Adams, H. E.
Amborn, G. W.
Armstrong, W. J.

Barry, W. B.
Basford, H. R.
Baurhyte, W.
Beck, A. C.
Berkley, J. M.
Boardman, W. F.
Bostwick, H.
Britton, J. A.
Britton, Van E.
Britton, J. A., Jr.,
Byerly, H. O.
Babcock, Chas. B.
Barbour, F. F.
Braundt, A. U.
Burdick, R. H.
Brown, M. R.

Cantrell, R. J.
Cardiff, R. L
Carson, A. C.
Clark, O. E.
Clark, R. L.
Clements, J.
Coghlan, J. P.
Coleman, S. Waldo.
Cope, Clarence
Cressey, F. A., Jr.
Campbell, S. S
Campbell, D. W.
Chandler, L. F.
Cronise, F. E.
Collins, G. H
Cobick, W. H.
Corey, C. L
Crossman, R.

Davidson, Jack P.
Davidson, W.
Dorr, W. J
Douglass, P. I.
Du Val, Wm. M.
Davis, A. C.
Davis, R. O.
Demming, E. C.
Drum, F. G.

Foote, D. H.
Florence, E. W.
Foster, W. H.

Foveaux, F.
Froelich, C.
Funk, P. C.
Furniss, Geo. H.
Farwell, J. D.
Forney, C. S. S
Fitzpatrick, F. E.

Green, F. A.
Grover, Sherwood
Gilbert, F.

Hamilton, S. P.
Hargreaves, R. H.
Henderson, W. M.
Heryford, H. B.
Hockenbeamer, A. F.
Holberton, Geo. C.
Hollege, G.
Hunt, J. H.
Hall, A. E.
Henley, E. B.
Haugh, Paul
Hall, M. G.
Hill, J. H.

Jason, W. E.
Jones, E. C.
Jones, E. S.
Jones, F. C.
Jones, L. B
Jones, H. H.

Kaneen, John S.
Keyes, H. C.
Kapus, Wm. M.
Kirk, Geo.
Kline, W. H.
Kohlwey, W. D.
Kuster, J. D.
Kepplemann, D. E.
Kales, F. A.
Kinney, G. I.
Kempf, John, Jr.

Leach, F. A. Jr.
Lisberger, S. J.
Lloyd, A. J.
Lowe, L. P.
Lemmon, H. A
Lane, J. Warren

Martin, J.

McKillup, C. W.
Morgan, W. R.
Mulgrew, J. J.
Maddock, G. F.
Miller, C. O. G.

Newhert, L. H.
Niesser, Otto

Osborn, W. E.
Oliver, E. L.

Parker, J. F.
Pennover, C. H.
Poingdestre, J. E.
Parratt, A. P.
Parker, F. C.
Powell, R. C.
Pedersen, B. S.
Prutzman, P. W.

Ray, D. C.
Reynolds, L. E.
Rix, E. A.
Rix, A. J.
Reid, J. R.

Stamps, Chas. F.
Sessions, Henry N.
Squires, H. B
Shuhaw, W. W.
Sprague, H. H.
Shaeffer, F. J.

Thompson, R. J.
Tredidgo, Don A.
Terney, J. W.

Valentine, R. P.
Vance, C. S.
Vander Naillen, R. L.
Vanderwhite, A. J.
Varney, F. H.

Weber, H.
Werry, J.
Walton, S. V.
Walker, F. H.
Worthington, J. S.
Wise, J. H.
White, W. A.
Wickersham, P. C.
Wilson, F.

Associate Members.

Z. T. Bell
G. W. Ackerman
Cal. Light & Fuel Co.
Chico Dist., Pac. Gas & El. Co.
Colusa Dist. Pac. Gas & El. Co.
Dresser, S. R. Mfg. Co.
General Gas Light Co.
Goodman, Patrick
Holophane Glass Co.
Humphreys Co.
Journal of El., Power and Gas
Keene, R. E. G.
Holbrook, Merrill & Stetson
Light, Geo.
Lindsay Light Co
Los Gatos Ice, Gas & El. Co.
Modesto Gas Co.
Mueller, H. Mfg. Co.
Marin Dist., Pac. G. & El. Co.
Nevada Dist., Pac. Gas & El. Co.
Palo Alto Gas Co.
Petaluma Dist. Pac. G. & El. Co.
Pacific Hardware & Steel Co.
Pacific Light & Power Co.
Robertson, Tom P.
Oregon Power Co.
McGeorge & Cooper Mfg. Co.
San Jose Dist., Pac. G. & E. Co.
Sacramento Elec., Gas & R'y Co.
San Francisco Gas & Elec. Co.
San Luis Obispo G. & El. Co.
Western States Gas & El. Co.
Southern California Edison Co.
The Schneider & Trenkamp Co.
The Standard Meter Co.
The W. F. Boardman Co.
Town of Santa Clara
The Stacey Mfg. Co.
Vallejo Dist., Pac. G. & El. Co.
Wood, R. D. & Co.
Woodland Dist., Pac. G. & E. Co.
Welsbach Company.

List of Applications for Membership.

Regular.

1. W. J. Armstrong,
   Representative, Oakland Gas, Light & Heat Co., Oakland, Cal.
2. Charles B. Babcock,
   Coast Representative, General Gas Light Co., San Francisco.
3. A. U. Brandt,
   Supt. Elec. Dist., Oakland Gas, Light & Heat Co., Oakland, Cal.
4. John A. Britton, Jr.,
   Asst. Gas. Dept., Pacific Gas & Electric Co., San Francisco.
5. Mortimer R. Brown,
   Comcl. Dept., Oakland Gas, Light & Heat Co., Oakland, Cal.
6. S. S. Campbell,
   Comcl. Dept., Oakland Gas, Light & Heat Co., Oakland, Cal.
7. Roy Crossman,
   Asst. Gas Extension Dept., Oakland Gas, Light & Heat Co., Oakland, Cal.
8. Jack P. Davidson,
   Salesman, The W. F. Boardman Co., San Francisco.
9. D. H. Foote,
   Secretary, Pacific Gas & Electric Co., San Francisco.
10. Frank Gilbert,
    Comcl. Dept., Oakland Gas, Light & Heat Co., Oakland, Cal.
11. Frank H. Hess,
    Manager, Home Gas Co., Porterville, Cal.
12. F. A. Kales,
    Draftsman, Oakland Gas, Light & Heat Co., Oakland, Cal.
13. Geo. F. Maddock,
    Engineer, 2515 College Avenue, Berkeley, Cal.
14. Alfred P. Parratt,
    Agent, Oakland Gas, Light & Heat Co., Berkeley, Cal.
15. Richard C Powell,
    Supt. Elec. Dist., Oakland Gas, Light & Heat Co., Oakland, Cal.
16. Chas. A. Rice,
    Gas Dept., Pacific Gas & Electric Co., Chico, Cal.
17. W. W. Shuhaw,
    Chief Clerk, Pacific Gas & Electric Co., San Leandro, Cal.
18. H. B. Squires,
    Otis & Squires, Mfg. Agents, San Francisco.
19. J. W. Terney,
    Foreman Gas Meter Dept., Oakland Gas, Light & Heat Co., Oakland, Cal.
20. P. C. Wickersham,
    Comcl. Dept. Oakland Gas, Light & Heat Co., Oakland, Cal.
21. Jas. H. Wise,
    Asst. Gen'l Manager, Pacific Gas & Electric Co., San Francisco.
22. W. W. S. Butler,
    General Manager, Western States Gas & Electric Co., Stockton, Cal.
23. Don A. Tregidgo,
    Asst. Dist. Dept., San Francisco Gas & Electric Co., San Francisco.
24. F. F. Barbour,
    Asst. to Pres., Pacific Gas & Electric Co., San Francisco.
25. F. H. Walker,
    Agent, Walker Stove & Range Co., San Francisco.
26. A. Emory Wishon,
    Asst. General Manager, San Joaquin Light & Power Co., Bakersfield, Cal.
27. H. A. Lemmon,
    Supt., Carson City Coal Gas Co., Carson City, Nevada.
28. M. G. Hall,
    Manager, Pacific Gas & Electric Co., Santa Rosa, Cal.
29. J. H. Hill,
    California Manager, Pittsburg Meter Co., San Francisco.
30. Edwin Letts Oliver,
    Manager Oliver Continuous Filter Co., San Francisco.
31. A. F. Derrick,
    Foreman, Oakland Gas, Light & Heat Co., Oakland, Cal.
32. F. J. Schaffer,
    Asst. Supt., Southern California Gas Co., Los Angeles, Cal.
33. E. A. Gimper,
    Supt., Bakersfield Gas Co., Bakersfield, Cal
34. A. C. Davis,
    Gas Steam Specialties, San Francisco
35. R. H. Burdick,
    Asst. Supt., San Diego Cons. Gas & Electric Co, San Diego, Cal.
36. Jos. S. Worthington,
    Supt., Municipal Gas Works, Santa Clara, Cal.
37. C. M. Crow,
    Div. Mgr., Pacific Light & Power Co., San Bernardino, Cal.
38. E. C. Demming,
    Supt. Gas Dist., Sacramento Electric, Gas & Railway Co., Sacramento, Cal.
39. H. H. Sprague,
    President, Sprague Meter Co., Bridgeport, Conn.

Associate.

1. Holbrook, Merrill & Stetson,
   San Francisco, Cal.
2. F. P. Woy,
   Manager, Albuquerque Gas, Electric Light & Power Co., Albuquerque, N. M
3. Geo. W. Ackerman,
   Salesman, Walker Stove & Range Co., San Francisco.
4. Reliable Eng. & Mfg. Co.,
   Pasadena, Cal.
5. Oregon Power Company,
   Eugene, Ore.
6. McGeorge & Cooper Mfg. Co.,
   322 Sheldon Bldg., San Francisco.

REPORT OF SECRETARY AND TREASURER.

September 11th, 1911.

Balance on hand—		
General Fund	$ 195.11	
Library Fund	388.18	
Total	$ 583.29	
Dues	$1,745.00	
Initiation Fees	290.00	
Badges	2.50	
Miscellaneous acct. Bank Interest	3.63	
Sale of Volumes	13.50	
Volume No. 6, advertisements	579.25	
18th Meeting, from Journals, acct. reporting fees	75.00	2,708.88
Total receipts		$3,292.17
Expenses 18th Convention	$1,528.30	
Purchase of books, etc., for library	123.01	
Expenses Secretary's Office	434.07	
Printing and Mailing Volume No. 8	928.19	3,013.57
September 11, 1911. Balance on hand—		
General Fund	13.43	
Library Fund	265.17	278.60
		$3,292.17
Volume No. 8—		
Cost of Printing, postage, etc.	$ 928.19	
Less, acct. advertisements	579.25	
Net cost of Volume		$ 348.94
Badges—		
On hand September 10, 1910	2	
Sold	1	
On hand September 11, 1911	1	
Membership—		
On Books—Regular Members	212	
On Books—Associate Members	68	280
Elected 18th Meeting, Sept. 20, 1910—		
Regular	68	
Associate	15	83
Total Membership		363
Resigned	9	
Dropped	9	18
Total Membership, Sept. 11, 1911		345
Honorary	3	
Regular	268	
Associate	74	

LIST OF VOUCHERS.

No.	Favor Whom. Account.	Amount.
1.	Bostwick, postage and stationery	$ 34.75
2.	Mercantile Bank, collection charges	2.20
3.	Payot, Stratford & Kerr, stationery and printing	71.50
4.	Pacific Photo Art Co., half-tone prints	8.25
5.	Lederer-Street & Zeus, stationery	15.62
6.	S. F. G. & E. Co., acct. telegraph tolls	1.75
7.	H. Bostwick, salary Sept., 1910, to Aug., 1911	300.00
8.	P. G. & E. Co., acct. telegraph tolls	3.00
9.	Shreve & Co., medal	65.00
10.	Wells, Fargo & Co., express charges	4.80
11.	H. Bostwick, expenses attendance 18th meeting	68.15
12.	Hotel Alexandria, banquet 18th meeting	975.00
13.	H. H. Harris, reporting 18th meeting	109.90
14.	Pease Bros., use of furniture 18th meeting	3.50
15.	C. S. Vance, miscellaneous expenses 18th meeting	31.50
16.	Brunt Co., menu and program	96.35
17.	Wm. Schade, miscellaneous expense 18th meeting	12.10
18.	Whitehead & Hoag Co., badges 18th meeting	112.00
19.	Auditorium Co., rent of hall 18th meeting	40.00
20.	C. S. Vance, telegram	2.00
21.	H. Wilson, stenographer	5.00
22.	Philadelphia Book Co., books, library	49.50
23.	J. Costa, premium insurance policies	10.80
24.	Wells Fargo & Co., express charges, books	1.65
25.	Keuffel & Esser Co., acct. library	13.50
26.	Isaac Upham Co., acct. library	12.00
27.	Progressive Age, acct. library	3.00
28.	Gas World, acct. library	4.79
29.	Progressive Age, acct. library	3.00
30.	Gas Industry, acct library	2.00
31.	E. C. Brown, copy Brown's Directory	5.27
32.	Payot, Stratford & Kerr, acct. library	17.50
33.	Payot, Stratford & Kerr, printing Volume No. 8	880.24
34.	American Dist. Tel. Co., messenger service	5.20
35.	Technical Pub. Co., cuts, etc., Volume No. 8	42.35
		$3,013.57

Resignations.

Regular.

1. Wm. Angus ....San Leandro, Cal.
2. A. Cartley ....Honolulu, T. H.
3. Chas. R. Collins ....Seattle, Wash.
4. Vanderlynn Stow ....San Francisco, Cal.
5. F. L. Wright ....Prescott, Ariz

Associate.

6. Sam Heyman ....San Francisco, Cal.
7. Long Beach Gas Co. ....Long Beach, Cal.
8. San Joaquin Light & Power Co ....Fresno, Cal.
9. Suburban Electric Light Co ....San Leandro, Cal.

Members Dropped.

Regular.

1. O. F. Anderson ....Los Angeles, Cal.
2. Ira C. Carter ....Honolulu, T. H.
3. Edw. Steinmueller ....Chicago, Ill.
4. A. E. Hursh ....Selma, Cal.
5. H. L. Delaney ....San Francisco, Cal.

Associate.

6. C. O'D. Blanchfield ....San Francisco, Cal.
7. Godfrey Fritz ....Los Angeles, Cal.
8. Chris Sieber ....Woodland, Cal.
9. McCormick-Henderson Co. ....San Francisco, Cal.

JOURNAL OF ELECTRICITY
POWER AND GAS

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Robert Sibley, Treasurer and Editor in Chief
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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

A Public Service Corporation Man's Attitude

Public opinion and more especially public desires and ambitions in proposed relationships of the municipality with the public service corporation are as vacillating as the fads which create the fabulous Belgian hare industries one year and starve them to death the next. When not properly directed, desires and ambitions on the part of the public will retard municipal growth and the freedom of natural progress as surely as the fashions of the day hobble the energies of our women. Not only do these fashions hobble the women in their personal attire, but they waste enormous energies in public agitation as was done in the city of Rochester in an endeavor to change the heights of street car steps to meet the hobbled skirt limitations. Thus it is in case of the municipality, often misdirected public activity will lead a community into waste of energies which properly applied would have many fruitful results.

There are cases on record where the municipal ownership of public utilities has proved a marked success. There are many more which, by the careful juggling of the annual statements of receipts and expenditures, the fat office-holders have made the public believe are a success.

Be all this as it may. The fact remains that at intervals during the life of a municipality, the municipal ownership idea creeps heavily into the issues of political struggles. How often it has been found in the past that the ever jealous corporation has either concealed its records when the public demanded an open statement, or, due to almost criminal neglect of business methods on the part of the corporation, an accurate statement has been impossible.

At the recent Oakland convention of the Pacific Coast Gas Association, Professor C. L. Cory of the University of California presented a paper on the fixing of rates, which for its fairness, both to the public and to the corporation, was of remarkably high order. John A. Britton, who is general manager of one of California's most powerful corporations—namely the Pacific Gas & Electric Company—followed in the discussion of the paper. It was a treat to all those within his hearing to listen to Mr. Britton's remarks. Commenting first upon the able manner in which Professor Cory had handled his subject, he urged upon all corporations to have expert appraisements made of their holdings and their books in such accurate and accessible form that any call for public inspection by experts could easily and quickly be met. Mr. Britton's idea conveyed was that the inability of a corporation in the past to show a clean, accurate statement, had always been misinterpreted by the general public and taken by the public to mean that the public service corporation had something to conceal.

Mr. Britton was quite right when he made the statement that public uneasiness was largely brought

about by this element of supposed holding back on the part of the great corporations. Mr. Britton struck the keynote. Such breadth of view shown by a representative of a great public service corporation will do much toward the creating of a more wholesome understanding between the public service corporations and the public.

Puget Sound Rate Case

Elsewhere in these columns will be found an account of the recent court decisions affecting traffic rates within twelve miles of Tacoma and Seattle on the Puget Sound Electric Company's service.

The ruling is one of great importance and its influence will be widely felt in rate questions in the west. The court takes the ground that 7 per cent is not an unreasonable return on an investment; that mistakes of the company in the past cannot be assessed to the traveling public. The last statement was made in response to the showing that the company had not in the past set aside a proper sum to cover depreciation.

In the adjustment of traffic matters and the fixing of rates by a commission, many things must be brought into consideration. The only method that will give justice to both sides of any controversy is for the arbitrator to put himself as far as possible in such a frame of mind that both sides to the issue can be seen. In a word, great public service corporations have been running along for years untrammeled by any definite public regulations. Now comes the commission which intervenes according to recent laws. In readjusting matters, surely reasonable errors made in the past must be allowed for in the re-adjustment. Any individual engaged in the busy run of life will recall in a moment's thought what an enormous portion, even compared to the total outlay, is actually wasted by mistakes in launching any enterprise. Such mistakes, from our very makeup as human beings, seem to be unavoidable. In a calm, just, reasonable striking of a balance they should represent an intangible asset to the owners of a project, not as representing an interest account on a blunder which an unwieldly corporation desires to saddle on the long-suffering public, but as representing in good faith a certain capitalized amount of human brains and genius finally successful in overcoming human difficulties met in the evolution of an art.

The case is comparable to human attempts in the solution of a new mathematical problem. At first the subject is wholly unknown to us. We read, and we figure, making many mistakes as we go until finally after hours of laborious work, our task is complete. In the future progress of our engineering career we use the same identical problem thousands of times, but ever thereafter it only takes us a few minutes for the proper solution. Surely it is proper and right for the expert to charge for his services not only during the brief period now required in its solution, but also the interest on a certain capitalized valuation of the application of his brains and of experiences acquired from former mistakes and efforts.

Thus it is true that in making a proper valuation of any public service corporation, justice should give to the corporation a reasonable capitalized asset as representing in its particular case the proper amount in expenditure that the human element necessitated in overcoming human shortcomings met with in the advancement of the art.

The Big Meadows Dam

Elsewhere in these columns will be found a description of the proposed Big Meadows dam of the Great Western Power Company. This enterprise means the launching of an additional supply of power in enormous quantities. The project is an interesting one, first as an engineering undertaking, for it is said that the cost per acre foot of storage will be less than any other dam in the world of similar large proportions. The impetus given to large storage projects in the West during recent years has brought about a deep realization on the part of capital of the gigantic possibilities of such projects. It is said that Daniel Webster once opposed the appropriation of moneys on the part of the government for the erection of a fort along the coast of Oregon, concluding a brilliant opposition speech by saying: "Mr. President, what can we ever hope to do with this useless territory but a home of the sage brush and the jackrabbit" Long since brother Dan would have turned in his grave could he but realize the fallacy of his remarks.

In Egypt the late improvements on the Assouan dam have increased the storage capacity so that it stands first in the world; next in capacity is the Roosevelt dam; and the Big Meadows dam will rank third in similar engineering undertakings of the world.

The most interesting feature, however, is the useful purpose the storage of such enormous quantities of water will serve in carrying the burdens of the human race. The water will be used over and over again in its descending course from the mountains. Five great diversion projects will impede its onward way, developing thereby a total of over 500.000 h.p.

Hitherto the great agricultural valleys below have been subjected to hazardous floods in extremely moist years, brought about by the onslaught of run-off waters and waters caused by the melting snows in the high Sierras. The retaining of such an enormous flood storage in the mountains will do much to alleviate this condition.

Finally, having reached the beautiful stretch of agricultural country of central California in regulated quantities, the waters will once again be used to quench the thirst of thousands of acres of semi-arid lands, thus again blessing the State by its presence.

PERSONALS.

Henry E. Adams, a lighting official of Stockton, was a recent San Francisco visitor.

L. E. Waird, an electrical engineer of Sacramento, spent last Sunday at San Francisco.

J. C. Farrar, of J. C. Farrar & Co., electrical engineers, Los Angeles, was a recent San Francisco visitor.

Ely C. Hutchinson, of the Pelton Water Wheel Company's sales force, is spending a vacation in the redwoods.

Guy H. Talbot, president of the Pacific Power & Light Company of Portland, Ore., was at Tonopah, Nev., during the past week.

A. H. Babcock, chief electrical engineer of the Southern Pacific, spent the past week at Portland and other points in Oregon.

S. Waldo Coleman, manager of the Coast Counties Light & Power Company of Santa Cruz, was a recent visitor to the Bay cities.

J. L. Randolph, president of the Turlock Telephone Company, recently arrived from Turlock and spent a few days at San Francisco.

H. B. Herntord, who is connected with the Pacific Gas & Electric Company, with headquarters at Chico, was a recent San Francisco visitor.

J. M. Berkley, superintendent of the Southern California Gas Company, has returned to Los Angeles after spending a few days at San Francisco.

J. H. Wise, assistant general manager of the Pacific Gas & Electric Company, has just returned to San Francisco, after a trip to the site of the proposed Lake Spalding dam.

F. B. Gleason, manager of the Western Electric Company's San Francisco branch, recently returned from the East and is now on a trip through the interior of the State.

L. J. Corbett, hydraulic and electrical engineer, Spokane, Wash., has entered university work as Associate Professor of Electrical Engineering, at the University of Idaho, Moscow.

Sydney Sprout left last Monday for Siskiyou County on business connected with the construction of the Siskiyou Electric Power & Light Company's new hydroelectric development on the Klamath River.

K. G. Dunn, electrical engineer with Hunt, Mirk & Co., returned to San Francisco during the past week, from San Diego, where some important work is in progress for the San Diego Electric Railway Company.

John A. Britton, Jr., son of the well known public service corporation man bearing the same name, recently joined the Pacific Coast Gas Association and was blushingly introduced to the convention as a "chip off the old block."

O. C. Pratt, president of the Indian Valley Electric Light & Power Company, recently returned from a trip to Greenville, where improvements in the hydroelectric system are contemplated in view of the future possibilities of that section.

H. R. Noack, manager of Pierson Roeding & Co., announces that the firm will remove their offices from the Monadnock Building to the Rialto Building. A large space will be occupied on the ground floor at the corner of New Montgomery and Minna streets.

C. W. Forbes, general manager of the Sonora Telephone Company of Sonora, Mexico, is at San Francisco taking bids on a long distance telephone line, extending from Guaymas to Hermosillo. The cost of the pole line alone is estimated at about $10,000. The telephone equipment will be of high quality throughout.

E. O. Sessions of the Chicago engineering firm of Woodmansee, Davidson & Sessions, Inc., is a recent San Francisco visitor. Mr. Sessions is receiving congratulations of his many engineering friends on the able and efficient skill he has shown in the installation of the Long Beach Plant of the Southern California Edison Company.

Among the passengers on the steamer Maitai, which arrived Thursday was J. D. Douglas, manager of a suburban railway line out of Auckland. He is figuring on electrifying the system and has come to the United States to inspect the electric lines here. The new cars will be built in New Zealand, but all the machinery will be imported.

Wallace Foster of the San Rafael gas division, and Stanley Walton, of the commercial department of the Pacific Gas & Electric Company, are blushingly receiving the congratulations of their many friends over their tragic efforts in the burlesque council meeting held during the recent banquet of the Pacific Gas Association, in Oakland.

Carl D. Heise, who has long held a prominent position in the Pacific Coast sales department of the Westinghouse Electric & Manufacturing Company, has just been appointed as acting manager of the San Francisco district office. Wallace W. Briggs is now assistant sales manager of the company, with jurisdiction over the San Francisco, Los Angeles and Seattle offices. Although young in years, Heise is old in electrical experience. After taking an engineering course in the University of California he entered the San Francisco office of the Westinghouse Company and was soon installing hydroelectric plants in the early days of high-tension transmission work. After several years of field experience, he rejoined the sales force and the management has now shown its appreciation of his work.

TRADE NOTES.

The Great Northern Railway, which already has nearly 4000 miles of track equipped with telephone train dispatching equipment, has just placed an order with the Western Electric Company for thirty-two telephone selectors to equip its Cascade division.

The Union Iron Works Company of San Francisco have this week closed an order with W. G. Douglas, of Virginia City, Nevada, for one water wheel unit to be direct connected to an electric generator. This wheel will develop 500 h.p. under 1000 ft. head running 600 revolutions.

The Vancouver Power Company's new hydroelectric plant, on the Jordan River, forty-three miles from Victoria, turned over for the first time last Sunday. The 3000-kw. generator was built by the Allis-Chalmers Company and installed by Sanderson & Porter under the supervision of Wynn Meredith.

The following electrical equipment has been ordered by the Oakland & Antioch Railway Company, San Francisco, Cal., from the Westinghouse Electric & Manufacturing Company: 4 quadruple equipments No. 321 motors, 600-1200 V. U. S. control; 1 quadruple equipment No. 322-E motors; 1 locomotive equipped with 4 No. 308-B-6 motors.

The Pennsylvania Railroad Company has recently ordered fourteen Western Electric selectors for use in its Hudson tunnels. The section equipped is known as the Jersey City-Newark Division, and it is nine miles in length. The dispatcher will be located at what is known as the "S. C." tower, and No. 16 B. & S. copper line wire will be used.

The Fort Wayne Electric Works supplied the electrical equipment, totaling 250 h.p. in induction motors, for the mill of the Stockton Mealfalfa Company of Stockton. The new plant, located at Salida, is the largest alfalfa meal milling installation in the State of California. The milling machinery was supplied by the Williams Pulverizer & Crushing Company.

INDUSTRIAL

THE LAST WORD IN INDUSTRIAL LIGHTING EQUIPMENT.

While the past types of Holophane-D'Olier steel reflectors practically solved the industrial lighting problem by providing units of extremely high efficiency and wide applicability, there are certain conditions where those reflectors with their aluminum finish are unsuitable on account of deterioration due to acid fumes or excessive dirt or exposure.

It was with a view to meeting these adverse conditions that the Holophane Company perfected a new line of steel reflector having a tough enamel finish and with the holders and connections of copper.

These new reflectors here illustrated are finished both inside and out with a white enamel. This enamel is not affected by chemical fumes or by weather conditions and is very easily cleaned, which means that there is no corroding or other deterioration.

They are furnished with the extensive type of light distribution.

Three holding devices are now available for use with Holophane-D'Olier Reflectors. The clip spring holder is well known, being the type that has hitherto been supplied exclusively; a new 2¼ inch heel which admits using the steel reflectors with standard holders, and a porcelain socket holder which allows the use of steel reflectors in many installations where brass sockets are not permissible, are now supplied also. These holders as before stated are copper finished and are of a sturdier construction than those heretofore used.

The Holophane Company has just issued a very attractive leaflet covering its new enameled reflectors, in which complete data is given.

NEW WATTHOUR METERS.

The Thomson watthour meters—Type I-10, recently developed by the General Electric Company, are designed for 5 and 10-ampere, 100 to 120-volt, 2 wire and 200 to 240-volt, 2 and 3 wire, 40, 50, 60, 125 and 133-cycle circuits.

New Thompson Watthour Meter—Casing Closed

Their mechanical and electrical design represents the most advanced stage of the meter art—the former insuring light weight and compact and rugged construction, the latter affording great accuracy of measurement under the voltage, frequency, wave form and temperature variations ordinarily occurring on lighting circuits, and also, shielding the meter element from any stray fields liable to be encountered in ordinary practice.

The rotating element consists of a small aluminum disk mounted on a bronze shaft. The lower end of the shaft carries a removable steel pivot, the upper end has the worm for transmitting the motion of the disk to the registering mechanism. The upper and lower bearings are carried on an aluminum frame casting, which also supports the magnet and registering mechanism, thereby insuring permanent alignment. The upper bearing consists of a steel pin fastened to a removable brass plug and extending down into the rotor shaft, which is drilled to receive the same. The lower bearing is a selected Oriental sapphire mounted in the top of the

New Thompson Watthour Meter—Casing Opened

brass screw and resting on a spring. A brass collar at the top of the jewel screw prevents the pivot from jumping off the jewel surface and riding on the top edge of the jewel screw, in case of extreme short circuits or other violent disturbance. The pivot is made of highest grade piano steel hardened and polished. It is screwed into the lower end of the shaft so as to permit of its being readily replaced if necessary.

The register is of the three-dial type reading directly in kilowatt-hours, no multiplying constant being necessary. One complete revolution of the most rapidly moving pointer registers 10 kilowatt-hours, therefore, 1000 kilowatt-hours must be registered before the dials repeat. The dial face is of white porcelain having a dull finish. The registering mechanism is of such construction that it may be removed for resetting the dials, repairing the meter, etc., and be replaced without disturbing the mesh of the train of gears.

The permanent magnet controlling the full load speed of the rotating element is of semi-circular form and completely surrounds the register. The magnet is made of the very best magnet steel properly aged and hardened to insure absolute permanency. It is so assembled on the frame that the opening between the poles is brought close to the upper surface of the aluminum disk. The arrangements for regulating the full load and light load speeds afford great refinement in adjustment. Creeping on potential alone is entirely prevented. The meters are lagged by means of a copper punching, which acts as a short circuited secondary for the flux of the potential coils, and therefore, the meters will give satisfactory results in the measurement of inductive as well as non-inductive loads.

The terminals comprise four brass binding posts located

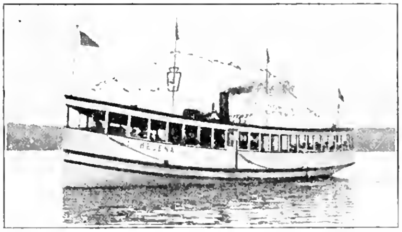
in a separate compartment made of moulded insulating compound, and fastened to a projecting part of the meter base. The terminals can be separately sealed, and the method employed for fastening the meter to the wall effectually prevents it being removed for the purpose of tampering.

For convenience in testing prior to installation, a testing loop is brought out through the frame just below the magnet. Any number of meters may be tested in series, without recording the losses in the potential circuits, by connecting the potential coil of each meter to the source of potential at some point before the line wires enter the meters.

The cover is drawn from zinc alloy, the bottom being threaded to fit in a groove in the meter base ,and when screwed firmly into place makes a perfectly dust-proof joint. Suitable means are provided for sealing the cover as well as terminal box.

EXHIBIT ON STEAM LAUNCH.

One of the most interesting and novel features of the Pennsylvania Electrical Association Convention at Conneaut Lake, Pennsylvania, was the floating exhibit of the Westinghouse Electric & Manufacturing Company. This consisted of a seventy-foot steam launch.



A New Idea for Commercial Exhibits

A complete line of electrical cooking and heating devices were displayed on the boat. Among these were chafing dishes, toaster stoves, coffee percolators, electric irons, radiators, glue pots, heating pads, nursery milk warmer, and a dentist's and physician's sterilizer.

ELECTRIC LOCOMOTIVES FOR THE TERRE HAUTE. INDIANAPOLIS & EASTERN TRACTION CO.

Many unique features are incorporated in the 240 h.p., 30-ton, all-steel electric switching locomotives (see Fig. 1), designed and built by the Terre Haute, Indianapolis & Eastern Traction Company at its Indianapolis shops.

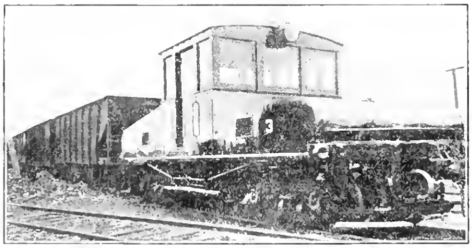


Fig. 1. Electric Locomotive on the Terre Haute, Indianapolis & Eastern Traction Co.

HL control equipment was selected for the locomotive because of its ability to continuously and reliably handle the large currents incident to shifting heavily loaded cars. With switching locomotives there are, necessarily, frequent applications of the controller to the first and second notches; that is, there is almost a continuous breaking of heavy currents. Because of this, HL control is preferable to the K types for such service. A further advantage of HL control for locomotive work is that the controller occupies but little space in the usually crowded cab and leaves plenty of room for the operator to step about and look out on all sides.

The switch group for the control and the reverser are mounted under one of the sloping hoods at one end of the cab, while the compressor and other air brake details, with the exception of apparatus that must be available for manipulation, are mounted under the other. The grid resistors for the control are mounted underneath the car. Small incandescent lamps for illuminating the air gauges in the cab are in circuit with lamps arranged in the hoods. This arrangement facilitates inspection of the equipment.

IMPROVED STENCILS FOR THE ELECTRIC SIGN PROJECTOR.

An entirely new electric sign as often as you desire at the nominal cost of fifty cents gives users of the Electric Sign Projector an opportunity to advertise special sales and new arrivals in an economical and effective manner right at the store front.

The sign projector, as the name implies, is not an electric sign but a device for projecting a sign from the window onto the sidewalk or on the side of a wall. The result is much the same as if a glass covered electric sign were imbedded in the sidewalk.

The sign is produced by greatly magnifying a small stencil. To improve the process of manufacturing so as to turn out stencils in large quantities at reduced cost was the first problem that presented itself to the manufacturers after the device was perfected. This problem has been so satisfactorily solved that stencils may now be procured in any quantity on short notice and at the small cost of fifty cents each.

NEW CATALOGS.

Duncan Direct Current Watthour Meter is the title of Bulletin No. 20 just published by the Duncan Electric Manufacturing Company of Lafayette, Indiana. The book is neatly printed and covers the subject thoroughly.

Bulletins Nos. 55 and 56 of the Richardson-Phoenix Co. have just made their appearance in the trade. The former deals with individual oiling and filtering systems, while the latter discusses fully the Economic Elevator Guide Lubricator. Both publications are interesting and profitable reading matter in addition to their value as catalogs.

The Westinghouse Electric & Manufacturing Co. has just issued a series of new bulletins. No. 1028 deals in Westinghouse rotary converters and No. 1190 is entitled Westinghouse Engine Driven Alternating Current Generators Type E. Five neatly printed folders dealing with Westinghouse electric tailor's iron, a.c. switchboard meters, d.c. switchboard meters, watthour meters, type OA, and type C watthour meters are also making their appearance among the trade.

TRADE NOTES.

S. Glen Vinson, vice-president and general manager of the Ideal Electric and Manufacturing Company of Mansfield, Ohio, has been visiting the Pacific Coast for the past three weeks with a view to establishing a branch house in the West.

R. B. Elder, vice-president and general manager of the Machinery and Supply Company, has resigned his position with this company to take charge of the branch house of the Ideal Electric and Manufacturing Company of Mansfield, Ohio, in this city. Location of office will be given in a later issue of the Journal.

NEWS NOTES

FINANCIAL.

OAKDALE, CAL.—Sealed bids were received by the clerk of the Board of Trustees up to September 18, 1911, for the purchase of $25,000 of water bonds and $12,000 of sewer bonds.

MORGAN HILL, CAL.—The Morgan Hill municipal bonds for a water system have been sold to the Bank of Morgan Hill for $13,334.80. They are bringing a premium of $334.80.

TACOMA, WASH.—A $10,000,000 mortgage has been filed by the Tacoma Gas Company with the county auditor in favor of the Continental Commercial Trust Company and Savings Bank of Chicago. The money is to be used for new improvements and an extension of the service.

VALLEJO, CAL.—There will be a bond election held late next month or early in November on the question of whether or not an issue shall be made providing for a municipal electric light plant and distributing plant. Also for the erection of a city hall and joint county jail; $150,000 will be voted for the electric light system and $75,000 for the city hall and jail.

ELKO, NEV.—Mr. Meyers, the representative of the Western Assets Company, the German branch of the Rothchilds, says that the town of Contact has a bright future. The company gets a 25 per cent interest in all the claims in the Contact district and in return will erect an electric smelter and build a railroad from the camp to the main line of the Southern Pacific railroad at Valley Pass, near Cobra. They will put in a big dam on the Little Salmon River and install a power plant to generate electricity to run the mines and smelter; the estimated cost of the plant, railroad, smelter and dam, being about $4,000,000.

ILLUMINATION.

BREMERTON, WASH.—The City Council has granted a franchise to Oroville Randolph and others of Seattle to construct and operate a gas plant in Bremerton.

SAN DIEGO, CAL.—The gas and light company is planning to lay mains and supply Ocean Beach with gas by the middle of October.

WALLA WALLA, WASH.—Mayor Cropp in a message to the municipal council of this city favored the immediate construction of a municipal power plant.

SEATTLE, WASH.—The Lighting Department of the city will erect a $9000 one story concrete power plant at 1179 Eastlake avenue. B. H. Graff, 601 American Bank Building, contractor.

SAN DIEGO, CAL.—The City Heights Improvement Association has been made a permanent organization and Walter Kirby has been made president. It has been decided to immediately install an electric street lighting system. Arrangements have been made with the San Diego Gas & Electric Company.

AUBURN, CAL.—J. L. Bryson, owner of the Rawhide mine at Towle and the Home Picket mine at Last Chance gives out the information that the deal has been finally closed whereby the Placer Electric Company, recently organized has become half owner of Bryson's property, together with other water ditches and rights. Bryson says he is to receive $1,240,000 for his half interest. The company plans to put in a big power plant on the American River near here.

SPOKANE, WASH.—City Engineer McCartney has received plans prepared by Architect K. K. Cutter for lamp posts on the Monroe street bridge. The plans will be inspected and steps taken to have the lamps manufactured.

KLAMATH FALLS, ORE.—The City Council has passed an ordinance granting to the W. F. Boardman Company a franchise for a period of 50 years for the erection and maintenance of a gas plant within the city of Klamath Falls.

SANTA BARBARA, CAL.—The Board of Supervisors will receive sealed bids up to October 16, for the purchase of a franchise granting the right to construct, and for a period of fifty years to maintain a system of gas pipes under and along the public roads and highways of the county.

RIVERSIDE, CAL.—The Ornamental Cement Stone Company has closed a contract with the Panada Development Company to make 70 concrete lamps to be used at the new mission town of Panada in Merced County. These will be old mission plan and cost several thousand dollars.

LIVERMORE, CAL.—Officials of the Pacific Gas & Electric Company visited this city last week to plan the erection of an extensive gas manufacturing plant for supplying the product to Pleasanton and Livermore for light and heat. General Superintendent P. C. Funk and President John de Sabla visited Livermore on the matter and held a number of conferences. The plant is to be one of the largest in this part of the State.

PORTERVILLE, CAL.—With a cash capital of $1,000,000 and with headquarters in Porterville, the organization has been completed of the Central Counties Gas Company of California, the consolidation of gas plants of the southern portion of the valley, which will furnish illuminating and fuel gas to Terra Bella, Porterville, Strathmore, Lindsay, Exeter, Visalia, Tulare and probably Lemoore and Hanford. Frank Hugh Hess, the organizer and manager of the Home Gas Company, of Porterville, who was one of the promoters of the consolidation as well, has been elected president and general manager of the new corporation. Bonds will be issued against the physical valuation of the company in amount sufficient to construct high pressure gas lines, which will be necessary to cover the territory.

INCORPORATIONS.

SEATTLE, WASH.—The Sound Electric Company of Seattle has been incorporated for $10,000 by E. Ellsworth, H. Schacht and Ed. Ellsworth.

ESCONDIDO, CAL.—The San Diego County Mutual Telephone & Telegraph Company is the name of a new telephone company incorporated here for $100,000.

OLYMPIA, WASH.—The Twisp Valley Power & Irrigation Company of Twisp has been incorporated with a capital stock of $20,000 by Harry Burke and C. F. Lohman.

PORT TOWNSEND, WASH.—The Olympic Electric Railway Company has been incorporated with a capital stock of $2,500,000. The road is to be completed with the funds from the sale of $2,000,000 in bonds.

ALBANY, ORE.—Articles of incorporation of The Sweet Home Water Company have been filed in the county clerk's office. The object of the company is to furnish water for domestic and other purposes to the citizens of Sweet Home. The capital stock of the company is $20,000. The incorporators are R. Watkinds, W. A. Malone, A. School and J Goings.

PORTLAND, ORE.—The Ewbank Power Transmission & Motor Company, with a capital of $250,000, has been incorporated and articles filed. This concern is to equip and construct electric street car lines and develop and furnish power. H. Ewbank, Jr., H. B. Ewbank, Sr., and G. Staples are the incorporators. The principal place of business is Portland

TELEPHONE AND TELEGRAPH.

SUSANVILLE, CAL.—The Johnstonville Telephone Company has been granted a franchise to erect and maintain a telephone system for a period of five years.

NAPA, CAL.—The Monticello people with the co-operation of the Cappell and Wooden Valley residents and the business men of Napa, are contemplating putting in a direct phone line between their town and this city.

PETALUMA, CAL.—W. D. Thomas, the electrician, has been awarded the contract to build the telephone line for the Gugielmetti Telephone Company to Cotati. The line will commence at the J. D. Ellis ranch and extend to the Jarvis ranch at Cotati.

RED BLUFF, CAL.—The Tehama County Telephone Company has ordered two carloads of poles to be used in erecting the farmers lines. More poles will be ordered as soon as the number needed can be estimated. These lines will connect with the central stations at Red Bluff and Corning.

LOS ANGELES, CAL.—Conclusion of negotiations are announced whereby another independent telephone company has been added. This latest connection was made at San Fernando, and over three hundred subscribers in that town and its surrounding territory are given the benefit of the Pacific long distance service. Likewise all subscribers of the Bell company now have direct communication with every telephone working out of the San Fernando exchange. The connection is similar to that put into effect August 1 with the Home Telephone Company of Covina, operating at Covina, Azusa, Glendora, Puente, Bassett, Rowland, Irwindale Charter Oak and Baldwin Park.

TRANSMISSION.

WEAVERVILLE, CAL.—The Board of Supervisors has granted permission to the Trinity Dredging Company for a franchise for an electric transmission line for a period of fifty years over highways and bridges.

SAN BERNARDINO, CAL.—The Board of Supervisors has passed an ordinance granting to the Pacific Light & Power Corporation a franchise for a period of 50 years, to operate and maintain an electric pole and wire system upon all public roads and highways of the county, outside of incorporated cities.

LOS ANGELES, CAL.—F. A. Raney, vice-president of the Riverbank department of Guy M. Rush Company, has just returned from Riverbank and states that contracts have been let and arrangements are being completed for the installation of transformers and sub-stations to furnish light and power to that section.

SUSANVILLE, CAL.—The Board of Trustees has passed an ordinance granting a franchise to erect, construct and maintain poles and wires for the transmission of electricity for heat, power and light under or upon the highways within the corporations of Susanville for the purpose of conducting a general power and lighting business within the town.

BLAINE, WASH.—The British Columbia Electric Railway Company, headquarters at Vancouver, B. C., has secured an acre site on the international boundary line for the establishment of a large concrete electric station to furnish electrical energy to this city. J. Edward Waller, the London civil engineer, has reported favorably on the project and contracts are being arranged.

SAN FRANCISCO, CAL.—The Chamber of Commerce of San Francisco is in receipt of a circular proposal from the Isthmian Canal Commission, calling for bids to furnish a plant and materials for a hydroelectric station at Gatun. Sealed bids will be received at the office of the general purchasing officer of the Isthmian Canal Commission, Washington, D. C., not later than 10:30 a. m. on October 9. Further information can be obtained at the office of the Chamber of Commerce of San Francisco, Merchants' Exchange building.

TRANSPORTATION.

LOS ANGELES, CAL.—The Board of Supervisors has sold a franchise to the Pacific Electric Company for certain roads in the Yerba & Paige tract, at the usual bid of $100.

NORTH YAKIMA, WASH.—Pinner & Griffith, 810 E. Yakima ave., this place, have secured the contract for erecting the plant of the Pacific Power & Light Company at this place, at $23,400.

SEATTLE, WASH.—W. H. Coughlin, American Bank building, has been granted a permit by the Board of Public Works for the clearing and grading of right of way for the Lake Burien and Oxbow electric railways.

GOLDENDALE, WASH.—The Pacific Light & Power Company has been granted a franchise by the county commissioners to construct a power line from this place to Centerville, a distance of seven miles, to cost $7000.

MONROVIA, CAL.—A committee from the Board of Trade, consisting of W. H. Evans and Thomas Bynum, has called on Messrs. Shoup and McMillan, officials of the Pacific Electric Company, in regards to an electric line for this city.

NATIONAL CITY, CAL.—Work will soon start on the relaying of the track of the electric division of the San Diego Southern Railway, between National City and San Diego. New ties will be put in and all the old light rails will be replaced with new 65-pound steel rails.

SEATTLE, WASH.—The Hofius Steel & Equipment Coming steel rails sufficient for 10 miles of trackage on the proposed Seattle-Tacoma short line, the general contract for which has been secured by the Homer Crosby Construction Company. Construction work on the railway will begin as soon as the steel is delivered.

SAN JOSE, CAL.—C. P. Anderson made application recently to the Supervisors for a franchise to build a railroad between this city and Almaden. The bidders want to run a double track line with steam, electric or gas cars or all. The proposed railroad will be built, it is announced, at a cost in the neighborhood of half a million dollars. The project has been financed and the preliminary surveys already made, according to Anderson's statement through his attorneys to the board.

SAN FRANCISCO, CAL.—The Supervisors have passed the bill authorizing the Board of Public Works to purchase 40 acres for the Geary street municipal railway, the entire cost not to exceed $350,000. The board also authorized the payment of $6900 to Eccles & Smith for 60,000 tie plates furnished for the Geary street railroad. The board laid over until a later date the matter of approving the "loop terminal" for the Geary road, recommended by Public Works Commissioner Laumeister.

SAN FRANCISCO, CAL.—Judge Seawell has handed down a decision in the suit of Daniel S. O'Brien against the Sutter Street Railway Company, holding that the company was illegally operating horse cars in Market street. Judge Seawell maintains that the company forfeited its Market street franchise when it stopped its cars at Sutter, in place of running the cars out to the end of the line. The suit was brought to test the right of the company to operate the cars from Sutter street to the ferry.

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EVAPORATIVE TESTS ON A WATER TUBE BOILER

BY R. F. CHEVALIER.

Evaporative tests were made by the writer in January and March, 1911, on one of the boilers in the Southern Pacific Company's Fruitvale power station, Fruitvale, California. This station has twelve 645 h.p. water tube boilers arranged in batteries with two boilers to the battery.

The object of these tests was to determine the efficiency of the boiler when operating at its normal rating. The test of January 5th was made to fulfill a guarantee clause in the contract of purchase. The results of these tests indicated a general performance of such a high degree of excellence that it seemed advisable to secure their confirmation through a second test carried out under the supervision of a committee of engineers. To this end the services of Professor W. F. Durand were secured and, on March 18th, another test was made with Professor Durand, W. C. Miller, engineer of power stations for the Southern Pacific Company, and the writer, acting as a committee. The results of this latter test served

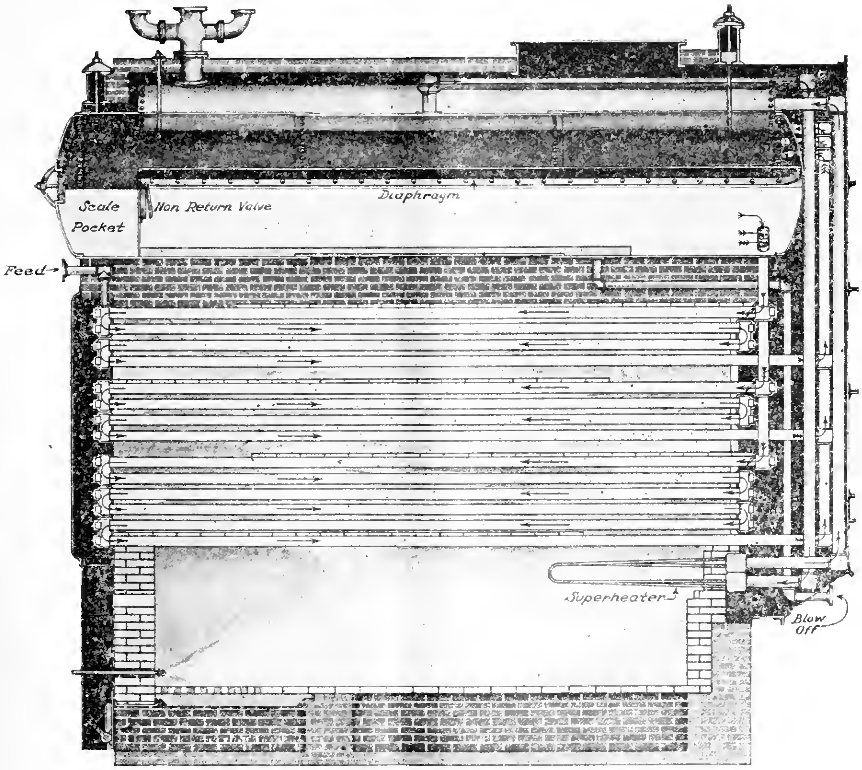


Fig. 1. Section of 645 H.P. Parker Boiler Showing Circulation of Water and Steam.

conclusively to confirm those of the earlier test and also to show that such performance could be repeated after a considerable period of operation.

The boiler tested is designated as boiler No. 2 in the above named power station. It is a Parker water tube boiler rated by the builders at 645 h.p. and designated as a compound 3 pass type; 2 wide lower elements and 4 wide intermediate. The boiler is 20 tubes wide and 14 tubes high. The tubes are 4 inches in diameter and 20 feet long. There are 2 drums 54 inches in diameter and 22 feet long. These are used for storing steam and water. There is one superheated steam drum 18 inches in diameter and 20 feet long. The steam and water drums shown in Fig. 2, are divided by a diaphragm of 1/4 inch steel plate riveted to the shell. This diaphragm extends from the rear head to within a short distance of the front head where it terminates, and to this end, and to the lower part of the drum, is riveted a vertical steel plate forming the diaphragm head. Thus is formed a pocket at the front to collect the scale discharged from the tubes, the drum being thereby divided into two separate chambers. In the diaphragm head is a manhole to which a cover is hinged on the inside and when closed makes a water tight joint. The pivot on which this cover swings is at the top of the manhole, and the weight of the door keeps it closed when in normal condition. This swinging manhole plate acts as a non-return or anti-priming valve. Its function is to allow the water discharged into the upper compartment to enter the lower compartment of the drum but to prevent the return of water to the former. The upper section in the drum is known as the steam space, the lower as the water space. The bottom of the drum below the level of the nipples leading to the elements forms the sediment pan or mud drum. An inverted angle iron with closed ends is placed over the blowoff opening, thus making the blowoff effective over considerable area.

The tubes are divided into three banks, each bank forming a pass. The upper bank is known as the feed element and acts as an economizer, through which the feed water must pass before entering the drums. The intermediate and lower banks are termed steaming elements. The bank of tubes comprising the economizer is 20 tubes wide by 4 tubes high, and is in the third pass of the gases. This bank is divided into two elements 10 tubes wide by 4 high. Each of these elements discharges into the drum over them. The feed water enters the front end of the first tube in the elements, which are the upper wing tubes. At the rear of each of these tubes a connection, by means of an extended nipple, is made between the junction box and the respective drums. In this junction box is placed a non-return valve which prevents the feed from going the wrong way and entering the drum

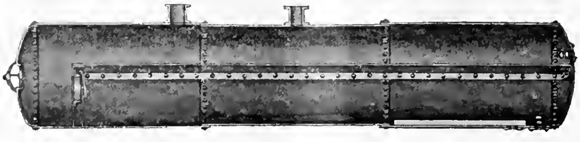


Fig. 2. Section of Steam and Water Drum Showing Diaphragm.

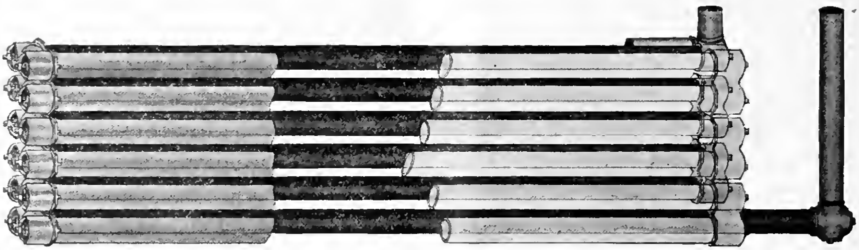


Fig. 3. One of the Evaporating Elements in First Pass.

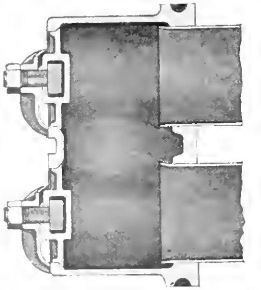


Fig. 4. Section of Junction Box.

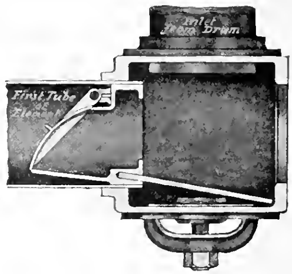


Fig. 5. Non-return or Check Valve.

through the inlet connection. The flow in the economizer elements is forward and backward alternately through the tubes in the top row; then, down to the

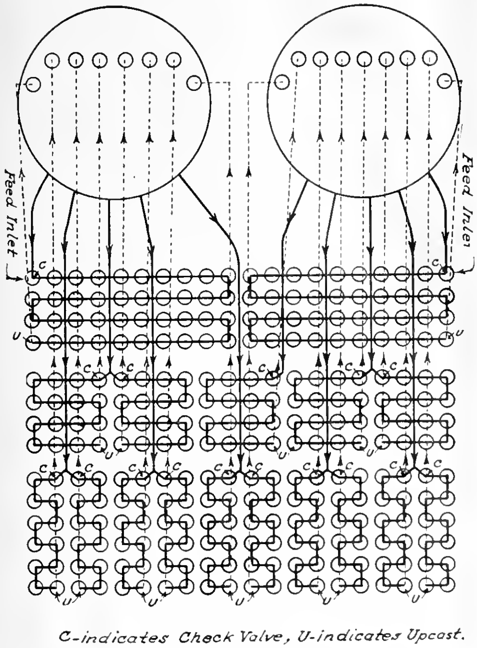


Fig. 6. Diagramatic Arrangement of Elements Showing Circulation of Water.

next row and so on, finally discharging through two vertical upcasts into the rear head of the drum above the diaphragm. The water then flows along the diaphragm into the front pocket, though the swinging manhole into the lower or water chamber of the drum, from whence it flows by gravity to the steaming elements. If the feed is shut off, the drum connection furnishes the economizer elements with water.

The intermediate bank of tubes is in the second pass of the gases and is composed of 5 elements 4 tubes wide and 4 tubes high. The water from the drum enters these elements on the upper or induction end through a downcast tube which is expanded in an inlet box which supplies two elements. Each element has a non-return valve in the inlet box which prevents the reversal of the flow of water. The water in these elements passes 4 times across, thence down to the next row and so on through the remaining tubes to the lower end of each element which is connected to the steam chamber by an independent upcast which discharges into the steam space of the drum.

The lower bank of tubes consists of ten elements, Fig. 3, 2 tubes wide and 6 high. The tubes in these elements, with the exception of the lower row which are in the furnace, form the first pass. The upper end of the elements are connected to the drums by means of down cast tubes and inlet boxes in the same manner as before mentioned. The water entering these elements passes across two tubes, thence down and across two tubes and so on to the last tube from whence it is discharged into the drum through an independent vertical upcast, connected to the lower end of each element. The elements are formed by expanding the tubes into junction boxes which hold two tube ends with a hand hole opening opposite each. The junction boxes, Fig. 4, have circular handholes, the covers of which are ground to the seat metal to metal, and, as the joints are made from the inside, the covers are held in place by the pressure.

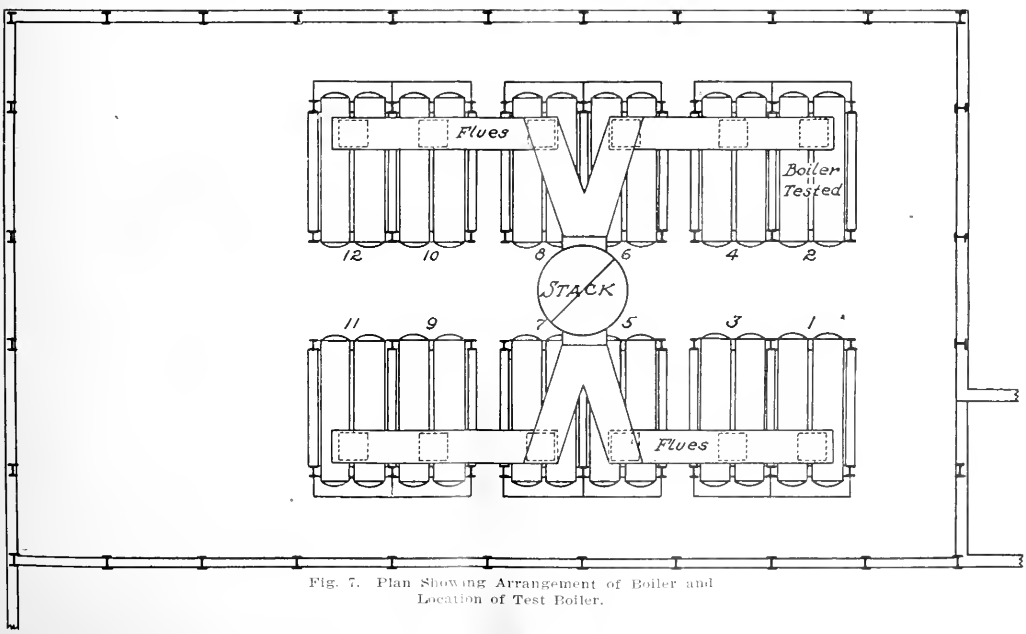


Fig. 7. Plan Showing Arrangement of Boiler and Location of Test Boiler.

The non-return valves, shown in Fig. 5, are fitted into the tube ends and are held in place by a loose pin which forms a positive stop when the handhole is closed. The valve is loosely hinged, has plenty of clearance and can be removed through the handhole for cleaning.

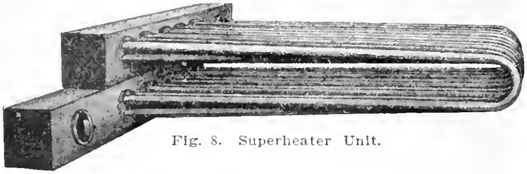


Fig. 8. Superheater Unit.

The steam is taken from the top of the drums by 5 inch tubes, one from each drum, to the bottom superheater header and after passing through the superheater tubes, (of which there are 32 loops with tubes 1¼ inches in diameter, bent in a U shape) passes into another header and is discharged through two 5 inch tubes into the superheater drum. The superheaters, Fig. 8, are located at the rear of the furnace below the lower row of tubes. The heated gases of combustion come in contact with the superheater heating surface at a high temperature, as only a small percentage of the heating surface of the boiler has been passed over by them before reaching the superheater. The superheater tubes are automatically flooded when the fires are extinguished and while raising steam from condensation in the superheater drums. The circulation and diagramatic arrangement of the elements are illustrated in Figs. 1 and 8.

Twelve of these boilers, arranged in 6 batteries, 2 boilers to the battery, comprise the entire boiler plant of this station. The general arrangement of the boilers is shown in Fig. 7.

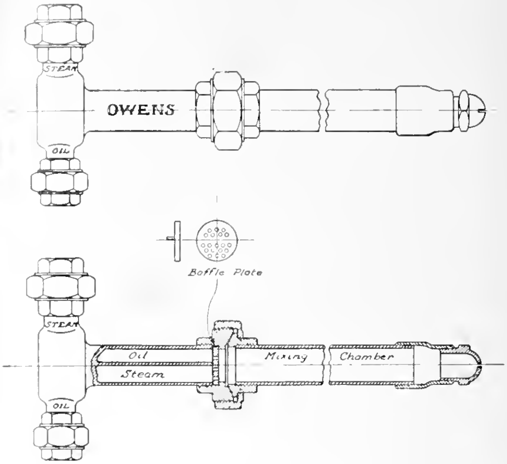


Fig. 9. Details of Oil Burner.

Furnace.

The furnace is of the ordinary type, with grate bars such as used for burning coal, the bridge wall being removed. The furnace is 10 feet wide by 16 feet 8 inches long, with an average height of 4 feet between the tubes and the furnace floor, making a volume of 666 cubic feet. Three burners, equally spaced across the width and with the tips extending 2 inches into the furnace enter through the boiler front. In front of each burner a rectangular space, 37 inches

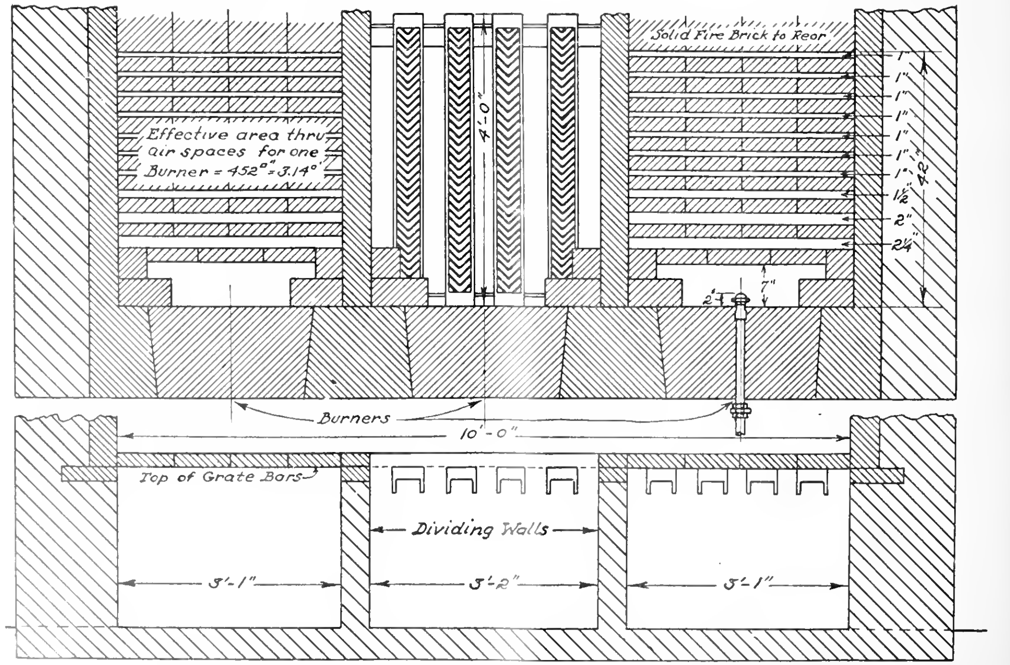


Fig. 10. Arrangement of Air Spaces and Grate Bars in Furnace and Dividing Walls in Ash Pit.

wide by 42 inches long, was left on the grate bars. In these spaces were placed soap fire-brick, laid in loosely and arranged so as to allow the admission of air for combustion through small openings running crosswise to the direction of the flame. A large rectangular opening was left beneath each burner. The ash pit is subdivided into three compartments, each of which supplies air to the individual setting for each of the burners. For arrangement and details see Fig. 10.

Burners.

An internal mixing type of burner, manufactured by P. J. Owens, was used. This burner is divided into two channels, the upper one containing the oil and the lower the steam. A plate having a number of small perforations is fixed to the end of these channels, the larger number or greater area of perforations being on the bottom where the steam passes through. The oil and steam, after passing through these perforations, enter a hollow tube or pipe which is used as a mixing chamber and at the end of which is a tip with a slot whereby the mixed oil and steam pass into the furnace in a fan shaped flame. For details see Fig. 9.

Water Heating Surface of the Boiler.

The heating surface was determined by actual measurement. All surfaces of the boiler in contact with water on one side and flame and hot gases on the other are taken into consideration and are tabulated below:

Tubes 4 in. diameter, circumference = 12.566 in = 1.0472 ft.
Tubes 18 ft. long = 18 × 1.0472 = 18.85 sq. ft. of H. S.
Tubes 20 ft. long = 20 × 1.0472 = 20.94 sq. ft. of H. S.

HEATING SURFACE BOTTOM ROW OF TUBES.
20 tubes with 18 ft. of length exposed to gases = 18.85 × 20 = 377.00 sq. ft = 6.20% of total

HEATING SURFACE 1ST PASS.
100 tubes with 20 ft. of length exposed to gases = 20.94 × 100 = 2094.00 sq. ft = 34.5% of total

HEATING SURFACE 2D PASS
80 tubes with 20 ft. of length exposed to gases = 20.94 × 80 = 1675.20 sq. ft. = 27.5% of total

HEATING SURFACE 3D PASS.
80 tubes with 20 ft. of length exposed to gases = 20.94 × 80 = 1675.20 sq. ft: = 27.5% of total

DRUMS.
2 drums 54 in. diameter, 18½ ft. of length exposed to gases Circumference = 14.1 ft. ½ of circum. 7 ft. = 7 × 18.5 × 2 = 259.00 sq. ft. = 4.3% of total

Total .... 6080.40 sq. ft.

Superheating Surface.

The superheating surface was determined by measurement. The actual surface exposed to the gases on one side and steam on the other were measured. On the test of January 5th, there were 40 loops in the superheater; the exposed heating surface was 134.4 sq. ft. During the interval between this test and the one of March 18th the superheating surface was reduced by the removal of 8 loops, the remaining 32 loops having a total of 107.4 sq. ft. of heating surface.

Rating of the Boiler.

The builders' rating of the boiler is 645 h.p. On this rating is based the percentage of overload. The rate of evaporation per sq. ft. of heating surface is based on the measurements as tabulated above.

Quality of Steam.

The steam is superheated. Observations of the temperature of the superheated steam were taken with a standardized thermometer placed in a well located in the outlet from the boiler. The location of the well is shown in Fig. 11.

Apparatus for Handling and Weighing the Feed Water.

This consisted of 2 pairs of platform scales placed upon a staging. On these scales tanks were placed for weighing the water. The water, after being weighed, was emptied into a receiving tank beneath, from which it was delivered to the boiler by a special pump. A

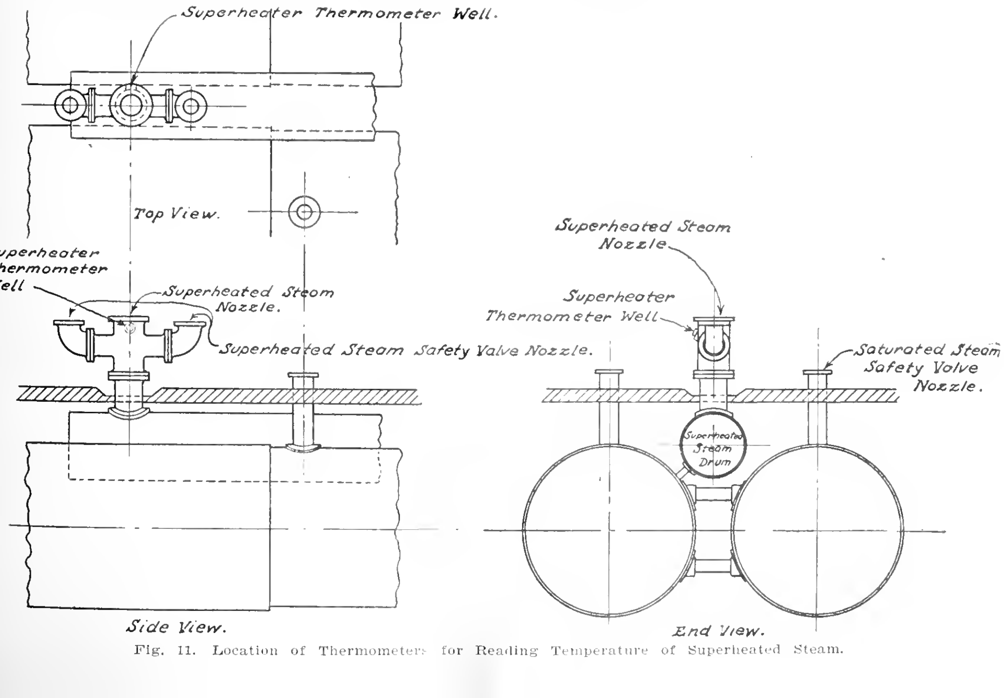


Fig. 11. Location of Thermometers for Reading Temperature of Superheated Steam.

hook gauge was placed in the receiving tank and at the beginning of the test the tank was filled so that the point of the hook just broke the surface of the water. This level was maintained at the end of each hour. The water in the boiler was maintained as near a level as consistent during the test. The outlets from the blowoffs were disconnected and blanked. The outlets from the water column and gauge glasses were carefully watched and no leakage occurred from either. At the end of each hour the actual amount of water was checked. The scales were standardized by representatives of the manufacturer.

Apparatus for Handling and Weighing the Fuel Oil.

This consisted of a standardized platform scale placed upon the same staging with those for weighing the water. Upon this scale was placed a tank into which the oil was pumped as required. From this tank the oil, after being weighed, was run by gravity into a receiving tank beneath, from which it was taken by a pump, passed through a heater and thence to the burners. This oil pump was fitted with a governor and an automatic relief valve. By these means a constant pressure was maintained in the oil line to the burners. The discharge from the relief valve led back to the tank from which the supply to the pump was taken. As the oil was emptied from the weighing tank, a small sample was collected, this operation occurring four times an hour. The samples collected represent a fair average of the quality of oil used during the test.

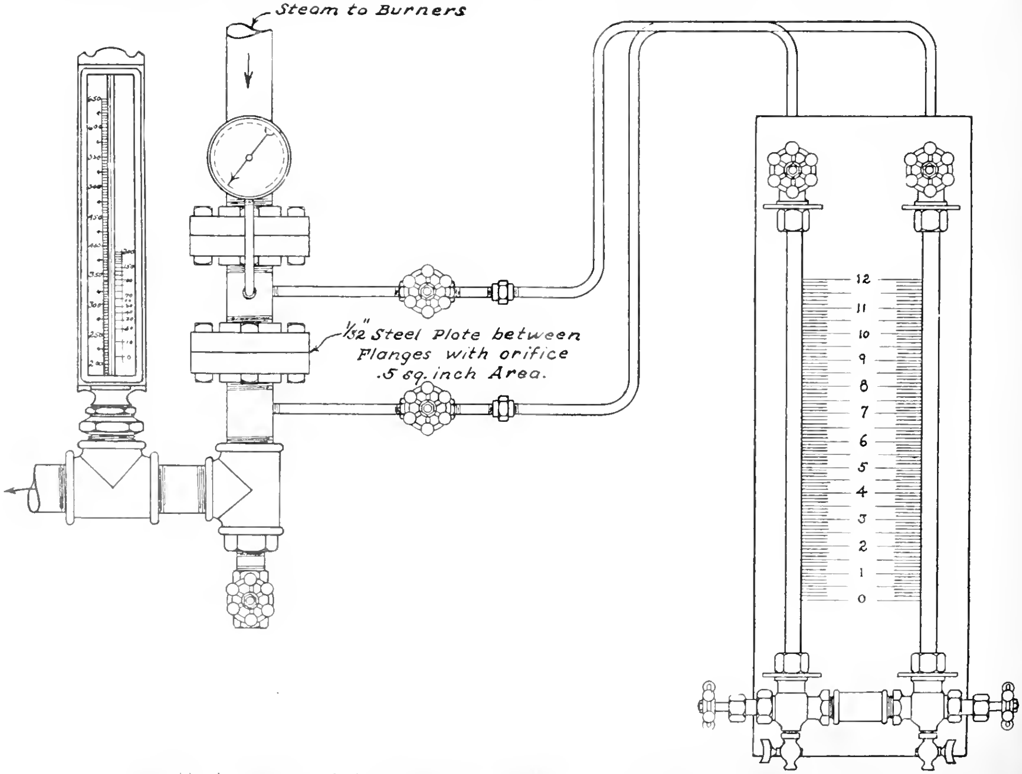
Heat Value and Characteristics of the Fuel.

At the completion of the test of January 5th the samples of oil collected were thoroughly mixed and divided into four portions. These were placed in small containers made of tin and sealed. One sample was delivered to the Southern Pacific Company, whose chemist made an analysis. One sample was used by the writer for analysis and the other two are in the writer's possession to be used for future reference if necessary. The results of the analysis by the Southern Pacific Company's chemist showed a lower heat value than that determined by the writer. For the test of March 18th, a sample was sent to Professor Edmund O'Neil, Dean of the Department of Chemistry of the University of California, Berkeley, for determining the heat value and water contained in the oil. As the writer's results were confirmed by those of Professor O'Neil the former only are given in detail in the present report. The writer's heat values were determined with a Parr calorimeter. Two determinations were made on each sample and the results averaged. The water contained in the oil was determined by distillation. The gravity was taken with a Westphal balance.

Steam to Burners.

This was superheated steam taken through an auxiliary valve on the nozzle attached to the superheater drum. The steam to the burner was measured during the test of March 18th. The method used for measuring this steam was as follows:

A diaphragm with an orifice .5 of an inch in area was placed in the steam line. On either side of this diaphragm holes were drilled and tapped for ¼ inch pipe. These pipes were connected to both legs of a



12. Arrangement of Air Spaces and Grate in Furnace and Dividing Walls in Ash Pit.

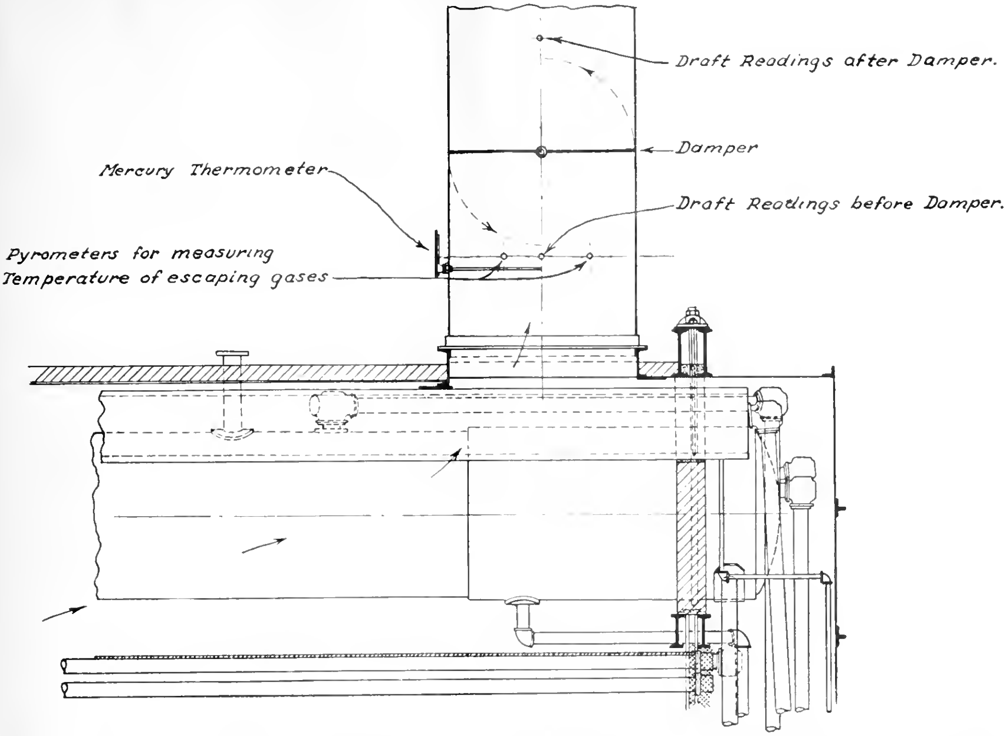


Fig. 13. Location of Pyrimeters for Taking Temperatures of Escaping Gases. Draft Readings Above and Below Damper.

manometer filled with mercury. In the steam pipe, ahead of the diaphragm, was placed a pressure gauge and beyond the diaphragm a thermometer was inserted to determine the temperature of the steam. The arrangement of this apparatus is shown in Fig. 12. After the test the orifice was calibrated by passing steam through under a series of noted conditions, the amount of such steam being determined by condensation and weighing. A tabulation of the principal results is given, also curves plotted from the data obtained. For these curves see Plates 9, 10 and 11.

General Plan of Tes: With Precautions Used.

All the thermometers and gauges used in the tests were calibrated and proper corrections made in the final computations. The boiler gauge was standardized with a dead weight tester. The scales for weighing the water and the oil were standardized before each test by representatives of the manufacturer.

To determine the amount of air entering the furnace, analysis of the gases of combustion for carbon dioxide were made by the use of the standard form of Orsat apparatus. Samples were taken where the gases leave the first pass and enter the second. The sampling tube was inserted at "L," the location of which is shown in Fig. 14.

The following observations were taken every 15 minutes. Steam, oil and draft pressures; temperatures of the superheated steam, steam to burners, feed water, fuel oil, boiler room, air entering ash pit and escaping gases. The temperature of the furnace and that of the gases passing through the boiler, were taken every 10 minutes.

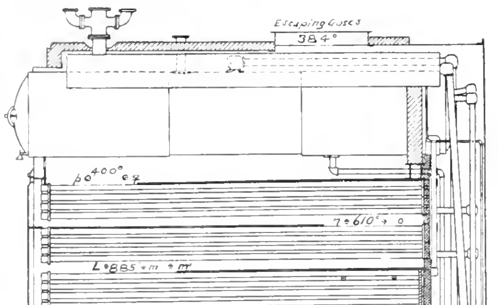
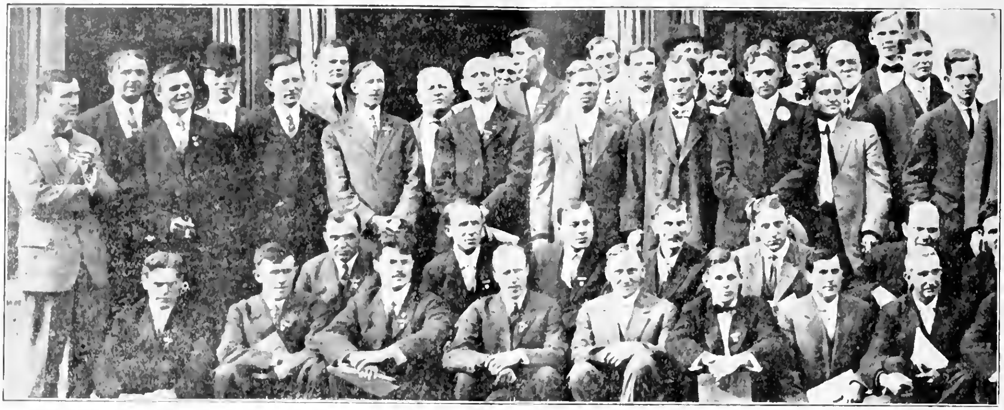


Fig. 14. Location of Holes for Sampling Gas Samples, Temperature and Draft Data

For determining the furnace temperature, a Fery's radiation pyrometer was used. The temperature of the gases through the boiler was taken with a Bristol electric pyrometer. Several couples were used, located at points where the gases left one pass to enter another. The location of these couples are shown in Fig. 14.

(To be continued.)



Delegates in Attendance at the Fourth Annual

NORTHWEST ELECTRIC LIGHT & POWER ASSOCIATION CONVENTION.

The fourth annual convention of the Northwest Electric Light & Power Association was held in the "Hall of Doges" at Spokane, Washington, on September 21, 22 and 23. Both in point of attendance and in value of the proceedings it was generally conceded to have been the most successful convention yet held. Aside from reading the several papers which will be published in subsequent issues, the most important business transacted was the unanimous decision to affiliate with the National Electric Light Association.

Norwood W. Brockett, Secy. Jas. E. Davidson, Pres.
Newly Elected Officers of the Northwest Light and Power Association.

This decision was in a large measure due to the vigorous personality and persuasive eloquence of T. C. Martin, executive secretary for the National Light Association who was in constant attendance at all meetings.

The newly elected officers for the ensuing year comprise Jas. E. Davidson, general manager of the Pacific Power & Light Company at Portland, president; J. M. Kinkaid of the Port Townsend Light & Power Company, vice-president for Washington, George Hartley of the Lewiston Light & Power Company, vice-president for Idaho; Norwood W. Brockett, secretary of the Seattle-Tacoma Power Company, secretary and treasurer.

The executive committee consists of H. L. Bleecker, Spokane, Wash.; W. J. Grambs, Seattle, Wash.; Arthur Gunn, Wenatchee, Wash.; O. B. Coldwell, Portland, Ore.; M. D. Spencer, Eugene, Ore.; L. B. Faulkner, Olympia, Wash.; J. S. Thornton, Aberdeen, Wash.; Douglass Almond, Anacortes, Wash.

Thursday's Sessions.

The convention was called to order on Thursday morning by President Douglass Allmond, who introduced W. J. Hindley, mayor of Spokane. Mayor Hindley welcomed the members of the association in a few well chosen words in which he emphasized their duties and obligations in the public service and as the exponents of the great fiat "Let there be light." With regard to the relation between the municipality and the corporation he stated that as the corporation had prepared the soil, planted the trees and nurtured them until they bore fruit it was certainly entitled to a just return for the fruit.

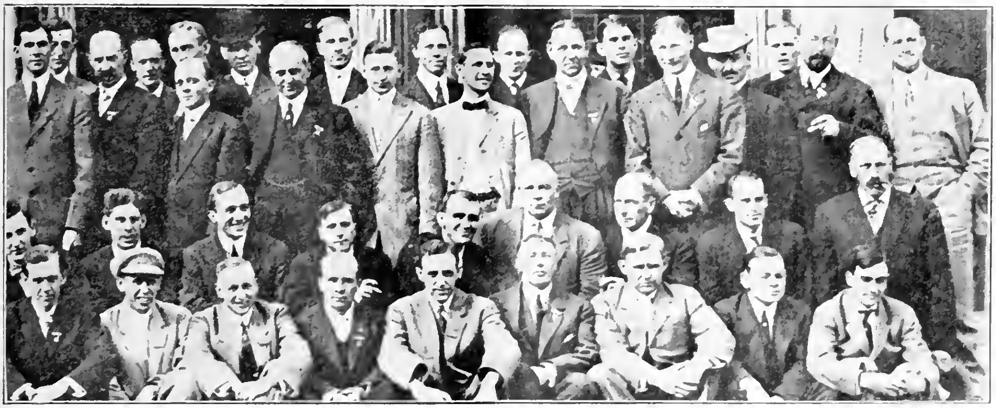
Secretary Norwood W. Brockett in responding to this address of welcome, complimented Mayor Hindley on the broad fairness of his views, as the representative of Spokane's commission form of government. A vote of thanks was tendered Mayor Hindley by all present.

The report of the treasurer showed that the association was in a most prosperous condition, having gained eight new member companies and lost six because of consolidations. The association is more than self supporting and has a large bank balance.

As chairman of the committee on rates M. C. Osborn, commercial agent of the Washington Water Power Company, gave a detailed explanation of the system employed by the Washington Water Power Company, giving blackboard illustrations. This system, likewise, will be illustrated in a subsequent issue of this journal.

The afternoon session was opened with the report of the legislative committee which showed that during the past year a public service commission had been established in Washington, was pending in Oregon and had been vetoed by the Governor of Idaho, after having been passed by the legislature. An employees' compensation act was passed in Washington and its constitutionality is now pending in the Supreme Court.

J. B. Fisken then read his paper on "Problems of Power Transmission and Distribution." This was



Convention of the Northwest Electric Light Association.

followed by S. C. Lindsay's contributed discussion on the same subject. An open discussion then followed, the principal points covered were the use of leased telephone service on transmission lines, in addition to company telephone service; the grounding of wires to avoid loss and damage by lightning disturbances: the life of poles, cross arms, etc., and the preserving of native timber; cost of line construction; the forming of clubs by members of a company.

This discussion was followed by the paper of W. J. Grambs, Seattle, Wash., on "Central Station Publicity and Commercial Policy (covering general relations between central stations and the general public.) The meeting adjourned to Friday morning, September 2d, at 10 a.m.

Friday's Session.

Meeting called to order by President at 10 a.m.

The first item on the program was the reading of the paper of Arthur Gunn, Wenatchee, Wash., on "New Business Methods for the Small Central Stations."

In the discussion Fred Shields, of Moscow, Idaho, laid stress on the fact that the fixing of rates in small central stations was a different problem than that of the larger cities, as it was not as easy to explain a complicated rate to the small municipalities as to the larger cities. The matter of the extension of lines to outlying districts was also discussed and different experiences narrated. The securing of new business in the small towns was discussed and several interesting cases of the methods employed were outlined.

A. C. McMicken of Portland, Oregon, then invited the association to hold its next annual convention at Portland, Oregon. This matter was referred to the executive committee.

An amendment was then proposed to Article 4, Section 2, beginning at the fourth line thereof, inserting the words "The President shall not be eligible to re-election for two years after his term has expired." This was also referred to the executive committee.

C. N. Huggins of Portland, Oregon, then read his paper on "Methods of Accounting in Connection with National & State Legislation."

In the discussion that followed, it was strongly urged that a uniform system of accounting be adopted, also that a valuation of water powers be established, in other words, a method for appraising the water powers. The system of a uniform system of accounting would also obviate the necessity of reporting to two or three commissions, as is now the case in many instances. It was here moved that the president appoint a committee of five to make further researches into this important problem.

The next paper to be read was that of A. C. McMicken of Portland, Oregon, on "Central Station Problems." Discussion was deferred until the afternoon session.

T. C. Martin, executive secretary of the National Electric Light Association, was then introduced to the convention, and explained the advantages to be gained by the local association affiliating with the National. He assured them they would in no way lose their identity or state rights, and would be greatly benefited by the assistance received from the National Association in matters of pernicious legislation, and in the distribution of valuable literature. He showed where other minor association had benefited to a great extent by such affiliation and urged a like action by this association. The matter was referred to the executive committee for action.

S. E. Doane of the National Electric Lamp Association, was then introduced and addressed the convention on the lamp situation, stating that it was only a matter of time when tungsten lamps would universally take the place of carbon lamps and showing where this would be of benefit both to the central station and the consumer. He stated that these lamps would be supplied in low wattages within a short time, and also dwelt on the value of the rate committee and its work.

The meeting was then adjourned to executive session.

A committee was appointed, consisting of O. B. Caldwell, W. J. Grambs, J. M. Kincaid, T. A. McGowan and Mr. Hallowell to submit nominations for officers.

The matter of amending the constitution to include British Columbia was then taken up and referred to the executive committee.

The first matter taken up at the afternoon session was the discussion of Mr. McMicken's paper on "Central Station Problems." The question arose as to the advisability of extending lines where a set revenue was not guaranteed. That in the larger cities it was deemed advisable to endeavor to reach all consumers, even though a given income is not in sight, in as much as the franchise practically entitled the people to the service if desired; whereas, in the small towns and outlying districts it perhaps would be wiser to extend lines only where a given income could be realized. That the tendency not to build to prospective consumers in the cities, on account of excess cost, tended to create a feeling for municipal ownership.

The next paper was that of R. E. Thatcher, Seattle, on "Meter Accuracy in Relation to Central Station Income." He was followed by Mr. J. G. Finley, Spokane, who read an exhaustive account of conditions with the different companies in this regard.

Mr. H. M. Winter, Seattle, then read his paper on "Electric Heating & Kindred Uses of Electricity." There was no discussion.

Mr. Cheney of Seattle, one of the staff of the Washington Underwriters, was then introduced and addressed the meeting on the strong necessity that all wiring in small towns, without inspector service, be done with the utmost care, to eliminate fire risk. He stated they were now endeavoring to have the agents of the different light and power companies in these small towns appointed inspectors, to see that all electrical work was properly done. That the fire losses the past year were in excess of $300,000, between 6 and 7 per cent of which was attributed to electrical causes.

A motion was then made and duly carried that hereafter all papers be prepared and printed and delivered in the hands of the members of the Association at least thirty days prior to the convening of the annual convention. The meeting then adjourned.

Saturday's Session.

Saturday morning was devoted to consideration of Norwood W. Brockett's paper on "Legal Aspects of the Light and Power Business," and to a paper on the results of municipal ownership.

The next in order was the following questions submitted by C. H. Cleaver and answered by H. V. Gates, Hillsboro, Ore.

Question: What is the best method of supplying current to a town for light and power, current supplied by water power about one mile from town, to the amount of 100 h.p.

Answer: For first class construction from your power site to the generators, the line to your town should be built in a modern manner, using the very latest methods. It does not pay to engage in slipshod ways. If a.c. current, install generators to be determined as best suiting your needs, and any voltage from 2000 to 2300. If a timber country, poles to be set 150 ft. apart; if no timber 125 feet. For that amount of power No. 6 wire could be used.

Question: What is the best method of selling power, meter or flat rate; if meter, what system of rates?

Answer: Local conditions govern this to a great extent. From that size of a town (800), using 100 h.p., where only about ½ load would be carried, that flat rate would be more responsive to the net revenue of any rate you could use.

The meeting here adjourned to executive session, President Allmond, presiding.

The first matter to come before the executive session was the questions of affiliation with the National Association and the Executive Committee was asked to report on same. They unanimously recommended the affiliation, and the following resolution was unanimously adopted:

"That the report of the executive committee on the question of affiliation with the National Association be and the same is hereby approved and ratified, with the understanding that the present automony of the Northwest Electric Light and Power Association be retained and the power of collection of dues and other funds be fully retained by this association. The secretary of this association to remit to the National Electric Light Association an amount not exceeding one-half of the fees now charged by the national association, as such amounts may become due, this resolution to take effect October 1st, 1911."

Report of Committee on Amendments, Mr. Brockett, chairman:

First—That Section 2, Article 7, of the Constitution, be stricken out. That is the clause requiring the Class A members to be initiated. Hereafter, Class A members will not have to pay initiation fees.

Moved and seconded this amendment be adopted. Carried unanimously.

That Section 3, Article 7, be made to read as follows: The annual fee of Class B members to be $5.00, and strike out that portion of the section requiring initiation fees.

Moved and seconded this amendment be adopted. Unanimously carried.

Section 4, Article 7, to be amended to read: Annual dues of Class C members to be $5.00 instead of $4.00 as at present. We make this raise of $1.00 to conform with the Constitution of the national association.

Moved and seconded that this amendment be adopted. Unanimously carried.

Section 2, Article 3, motion to amend by adding the words "British Columbia."

Moved and seconded that this amendment be adopted. Unanimously carried.

Section 2, Article 4, fourth line theroef, insert the words "The President shall not be elected to serve for two years after expiring term." Moved and seconded amendment be adopted. Unanimously carried.

Motion now made that the president and secretary make formal application covering the affiliation of the N. W. E. L. & P. Ass'n., with the National Electric Light Ass'n. Motion duly seconded and unanimously carried.

A motion was here offered that the constitution of the N. W. E. L. & P. Ass'n. be amended so as to conform in all details with the requirements of the N. E. L. Ass'n., and that the inserting of the necessary clauses into this constitution be left in the hands of the committee on amendments, its power to be lim-

ited to the resolution already adopted. This resolution was promptly voted down.

According to the Constitution, the president appointed the secretary-treasurer for the ensuing year, naming Mr. Norman W. Brockett of Seattle to succeed himself. The convention then adjourned.

Social Features.

Sandwiched in between the business sessions were many delightful dinners and excursions. Aside from the various private parties, were the smoker and dinner to the thirty novitiates in the Rejuvenated Sons of Jove on Friday night, preceding the rejuvenation, and the great convention banquet on Saturday night. Incomplete returns show the following daring spirits as new members: B. Gustad and Lester M. Simpson of the Grangeville Electric Light & Power Company, Grangeville, Idaho; Thaddeus S. Lane, president of the Home Telephone Company, Spokane; D. F. Fearing, National Carbon Company, Cleveland; M. D. Spencer, Oregon Power Company, Eugene, Ore.; M. McGowan, Idaho and Washington Light & Power Company, Spokane; H. R. Williams, Stevens County Power & Light Company, Colville; Arthur W. Hillis, Montana Electrical Company, Butte; Lee F. Austin, Austin-McCain Company, Spokane; Clyde L. Bankson, Spokane & Inland; Frank O. Berry, Mosso-Berry Electrical Company, Spokane; William A. Davis, city electrical inspector, Spokane; C. G. Gilster, Washington Electric Supply Company, Spokane; James A. Gorman and Arthur C. H. Miller, Washington Water Power Company; Dare Headington, Miller Engineering Company; Harry A. Kinney, Mosso-Berry Electrical Company, Spokane; Mahlon McCain, Austin-McCain Company, Spokane; Millard Sebern, Washington Electrical Supply Company, Spokane; Fred M. Shields, Idaho-Washington Light & Power Company, Moscow; Vincent G. Shin-Washington Water Power Company; Hugh L. Tinling, Mosso-Berry, Electrical Company; Earl R. Warnes, Spokane & Inland; H. I. Bargoin, Washington Electric Supply Company, and Henry T. Whitehouse, Washington Electric Supply Company.

George Otis Gray of the Gray Investment Company is statesman of the Rejuvenated Sons for eastern Washington, and W. J. Grambs of Seattle occupies a similar position for the western part of the State.

Thursday afternoon the visiting ladies were the guests of the Washington Water Power Company on an automobile trip to the Spokane Country Club. This was attended by thirty guests and a delightful trip was experienced. Tea was served at the club house and a pleasant social afternoon was spent, the party returning to Spokane in the evening.

In the evening an informal ball was held at the Hall of Doges, Davenports. Seventy-five couples attended this function and disappointment showed on the faces of all present when the concluding number was played. At 11:30 lunch was served in the "Halls of Palms" and the merry laughter voiced the good time the entire party seemed to be having. The affair was admirably handled and an atmosphere of welcome and hearty fellowship pervaded the hall.

Friday evening was devoted to viewing Spokane by electric light, and all members expressed great surprise at the modern, up-to-date illumination of this city, the number of display windows and signs, and the substantial, high-class character of these signs.

Saturday evening the lady visitors were the guests of the Washington Water Power Company at a theater party; they attended in a body and the performance was greatly enjoyed.

On Saturday afternoon the visitors were the guests of the Washington Water Power Company on an automobile excursion "viewing" Spokane.

Saturday evening at 7:30, the closing banquet was held in the Hall of Doges, Davenport's, Spokane, about 125 members being present. The hall was beautifully decorated, a toothsome menu prepared, and one and all started in for a rousing good time. Mr. H. V. Gates, of Hillsboro, acted as toastmaster.

The banquet broke up at 12:30, everybody tired, but happy, avowing this to be the most successful convention in the history of the association.

Sunday, September 24th—visiting guests invited by the Washington Water Power Company to make an automobile inspection trip of the Long Lake and Little Falls plants. About 75 attended, all reporting a grand time and expressing surprise at the Washington Water Power Company's immense undertaking at these points.

Among those who registered were:

Douglass Allmond, Anacortes Water Co., Anacortes, Wash.; C. R. Andrus, Pasco Power & Light Co., Pasco, Wash.; Thos. G. Aston, Washington Water Power Co., Spokane; B. P. Bailey, Pacific Power & Light Co., The Dalles, Ore.; A. H. Beckwith, G. R. Beekman, H. C. Billice and M. W. Birkett of the Washington Water Power Co.; Norwood W. Brockett, Seattle-Tacoma Power Co., Seattle; C. L. Cleaver, Granite Falls Power & Light Co., Granite Falls, Wash.; W. R. Chrysler and G. M. Corey, W. W. P. Co.; O. B. Coldwell, Portland Ry., Light & Power Co., Portland; Darrel Corbett, Chas. C. Moore & Co., Engrs., Seattle; J. E. Davidson, Pacific Power & Light Co., Portland; S. E. Doane, National Electric Lamp Association, Cleveland; H. B. Dunn, Seattle Tacoma Power Co., Seattle; Eugene Enloe, Big Bend Light & Power Co., Spokane; A. R. Fairchild, W. W. P. Co., Spokane; F. R. Fantorn, W. W. P. Co., Colfax; D. F. Fearing, National Carbon Co., Cleveland; W. W. Ferris, Grays Harbor Railway, Light & Power Co., Aberdeen, Wash.; J. G. Finley, W. W. P. Co., Spokane; H. C. Fiske and J. B. Fisken, W. W. P. Co., Spokane; J. G. Flynn, Portland Railway, Light & Power Co.; C. S. Foster, W. W. P. Co., Spokane; H. E. Gates, General Electric Co., Spokane; H. V. Gates, Hepner Light & Power Co., Hillsboro, Ore.; W. J. Grambs, Seattle Electric Co.; F. F. Griffin, W. W. P. Co., Spokane; Arthur Gunn, Wenatchee Valley Light & Power Co., Wenatchee; Albert S. Hall, Pacific Power & Light Co., Hood River, Ore.; L. W. Harper, Chelan Water Power Co., Chelan, Wash.; Arthur H. Halloran, Journal of Electricity, Power & Gas, San Francisco; D. F. Henderson, G. H. Hoppin and H. W. Howard, W. W. P. Co., Spokane; C. C. James, Seattle Electric Co., Seattle; J. J. Jennings, Lewis-Clark State Improvement Co., Lewiston, Idaho; J. D. Jamison, Westinghouse Electric & Mfg. Co., Spokane; Blaine L. Renio, Westinghouse Electric & Mfg. Co.; S. C. Lindsay, Seattle Electric Co., Seattle; C. F. Kirckhain, Seattle Electric Co., Seattle; J. M. Kincaid, Port Townsend Light & Power Co., Port Townsend; Charles Kolb, Wilbur Electrical Co., Spokane; H. R. Kriegman, Pacific Power & Light Co., North Yakima, Wash.; J. W. Leighton, Holabird Electric Co., Seattle; Chas. H. Lund, W. W. P. Co., Spokane; H. H. Levin, W. W. P. Co., Spokane; G. W. Longmeir, Pacific Power & Light Co., Prosser, Lewis A. Lewis, W. W. P. Co., Spokane; C. S. MacCalla, W. W. P. Co., Spokane; T. A. McGowan, Idaho & Washington Light & Power Co., Spokane; A. C. McMicken, Portland Railway, Light & Power Co., Portland; D. C. McKissick, Northwest Light & Water Co., Wallace, Idaho; T. C. Martin, National Electric Light Association, New York; G. A. Martin, Yamhill Electric Co., Newberg, Ore.; W. G. Martin, Bremerton Light & Fuel Co., Bremerton, Wash.; B. M. Merrill, W. W. P. Co., Spokane; V. C. Naylor, Pacific Power & Light Co., Goldendale; F. D. Nims, Western Canada Power Co., Vancouver, B. C.; C. P. Osborne, Portland Ry., Light & Power Co., Portland; M. C. Osborne, W. W. P. Co., Spokane; C. E. Parkes, W. W. P. Co., Spokane; H. B. Pierce, W. W. P. Co., Spokane; L. J. Pospisal, W. W. P. Co., Spokane; W. D. Roe, Wilbur Electrical Co., Wilbur, Wash.; F. L. Rohrbach, W. W. P. Co., Spokane; C. Rumwell, B. C. Electric Ry. Co., Vancouer, B. C.; Geo. S. Sanderson, Pacific Power & Light Co., Freewater, Ore.; Chas. A. Sind, W. W. P. Co., Spokane; O. Skiles, Pacific Power & Light Co., Sunnyside; M. D. Spencer, Oregon Power Co., Eugene; A. V. Stirling, W. W. P. Co., Spokane; R. E. Thatcher, Seattle Electric Co., Seattle; H. V. Tompkin; R. E. Tompkins, W. W. P. Co., Spokane; C. A. Turlay, Portalnd Ry., Light & Power Co., Vancouver, Wash.; H. A. Turner, Seattle Electric Co., Seattle; C. F. Uhden, W. W. P. Co., Spokane; G. W. Uzzell, W. W. P. Co., Spokane; E. A. West, Portland Railway, Light & Power Co., Portland; Thos. W. Weill, Kootenai Power Co., Coeur d'Alene, Idaho; H. R. Williams, Stevens Co., Power & Light Co., Colville, Wash.; J. S. Wurtell, W. W. P. Co., Spokane; H. M. Winter, Seattle Electric Co., Seattle.

PACIFIC COAST GAS ASSOCIATION.

The two following papers, the one by C. S. S. Forney, president of the Southern Counties Gas Company, and the other by C. M. Hunt, manager of the San Diego Consolidated Gas & Electric Company, were read before the recent Oakland convention of the association:

HIGH PRESSURE GAS DISTRIBUTION.

BY C. S. S. FORNEY.[1]

The service furnished to towns, villages and rural communities from the central generating station by high pressure trunk lines may be considered as suburban gas distribution.

The problems in connection with this work as to engineering and construction features are simple and direct and have a multitude of precedent and example to fortify and confirm the theories which any engineer will evolve by consideration of the cases presented.

The financing and organization of a company for this work required bold conception and conservative execution if the proposition involves the acquirement of existing properties and the linking and grouping together of towns previously served by unit generation.

The operation of such a property necessitates an unusual quality of supervision, because the properties are not under the eye of the management to the extent that single large plants and distributing systems are, and the employees are more removed from the direct influence of the management.

The logical method of estimating a system for suburban gas distribution by high pressure mains is to consider the ultimate territory to be served in its various aspect as a whole. This can be arrived at best by considering the towns which ultimately may be a part of the system even though there may be a number of other companies operating in the territory; as to conceive a project, it is necessary generally to disregard the existing conditions.

After determining the towns which may be served by a general system, the buildings in the various communities and in the suburban districts should be counted. Estimates based on population are usually arrived at by allowances for this, that, and the other condition, after assuming that so and so will happen or not happen, and if so and so does happen, it may result in something else.

The logical method of determining the number of its consumers in a given district is to have the houses and other buildings counted and segregated into two or three classes; that is to say, houses of a value of $3000, or less, and houses of a value of more than $3000 and where it is intended that commercial lighting shall be done, a separate segregation of the number of stores should be made and one classification of other buildings should include churches, public buildings, schools, etc.

There should be considered the ultimate development of the territory, based on prediction of what the conditions will be in ten years. This can be arrived at in a number of ways, but the best method is to take the number of acres of tillable land tributary to a certain town and consider the probable ultimate development of the area; that is to say, to consider whether it will be divided into small ranches, large ranches, towns, cities, etc., and where, as in Southern California, we have horticultural and agricultural development of high degree, consider how many acres of the highest class; orange groves, walnut groves, etc., have been developed to produce a certain sized town and then next to consider how many acres may be developed to the highest form from some of the lower classifications, and then determine what sized town will be produced thereby.

The relation of the size of the town of the inferior classes of farm development, should then be next considered and the two will result in a basis for predicting what the ultimate size of the town will be, based on the ultimate development of the contributory factors.

Other things may have to be considered, as the development of a seaport, the building of new lines of railroad, to what extent the town is dependent upon the adjacent farming developments and the result from its being suburban to some large community.

After these various factors have been studied and determined, the number of gas meters in service in 1920 should be assumed at being 90 per cent of all the buildings.

After determining the number of meters probable in the territory to be served by 1920, a basis of $100 per meter should be used to determine the capitalization required by the company in forming a company to serve a given territory. It is desirable to have a certain fixed relation between the various classes of capitalization; $150 per meter being the capital value of a gas property, the proportion of capital which represents the actual physical value of the property should not exceed 80 per cent thereof; the remaining 20 per cent representing intangible assets. This relation will be referred to subsequently in this paper.

In view of the new thought movement, which is so seriously and vitally affecting public service corporations, it seems desirable that the corporation should receive its charter from the State in which it is operating, to the end that, if conditions work a hardship under these circumstances, then that much sooner will the conditions be corrected.

There should be a straight line drawn between the securities which are sold for the purpose of raising money for the corporate needs of a company and those securities which are taken and held either for controlling purposes or as compensation for development and management. An excellent way to secure the effecting of such a plan is to arrange to escrow the stock to be sold with a trustee, under the terms of an agreement providing for the issuance of the stock under certain conditions.

After all of the foregoing has been considered and determined the next matter to undertake is to consider what arrangement would be made to serve the territory in the event that there were no gas plants now operating. Then consider and determine what arrangement would be made to serve the territory in the event that there were no gas plants operating in 1920.

After these two things have been determined co-

[1] President of Southern Counties Gas Company.

relate the two so that there will be a minimum loss in discarding existing plants. After determining the plant situation in 1920, the high pressure trunk line should be laid out with an idea of carrying the load at 40 pounds pressure, based on the amount of business in 1920.

The next problem involved is to fit the existing manufacturing plants into the trunk line system.

If the plan is well worked out, logically designed, and sound economical and engineering reasoning used, the problem of securing capital for the carrying out of the plan would be solved, if people were eager to bid for an opportunity to participate in 6 per cent regulated public service corporation securities.

The company with which the writer is connected, Southern Counties Gas Company of California, has approximately 6000 meters served by high pressure trunk lines, and high and low pressure distributing systems.

The high pressure trunk lines are at present operating under a pressure of 20 pounds, and at higher pressure are designed to supply the particular groups of towns served, for ten years to come.

We have shut down three small plants, but maintain them as a reserve against possible interruptions in sections of the high pressure mains. Eventually it is hoped to have the entire system served by two plants, operating at each end of the through trunk line, a distance of about seventy-five miles. When this condition is reached and the line completed, the system will be serving about 12,000 consumers.

By moderate pressure in the mains of 2 pounds, with individual regulations, we find that we are able to cut down our maintenance labor 50 per cent.

We are operating seventeen towns and maintain an office in each one. In some of the smaller towns we arrange with a local druggist to represent the company; and in the event of trouble complaints, or break downs, advice is telephoned to one of the given offices where an attendant is stationed, and from which the work of a particular group of consumers is handled.

Other economics have been effected by shutting down of plants, in labor and in fuel oil.

We have brought much suburban territory in touch with transmission lines, from which lateral have been run into sparsely settled district, making it possible to supply small isolated communities, which would not have had gas service otherwise for a long time to come.

The compression of gas has made possible its delivery to remote sections, with comparatively small mains, making it possible to consider favorably extensions which have heretofore been impracticable.

This class of distribution, however, represents comparatively high maintenance and operating cost, as the meter reading and collection of delinquent bills under such conditions involves considerable expense for transportation, and loss of employees' time in transit.

It is our practice to use only 1500 pound test line pipe on 2 inch, and larger, and we specify that the couplings should be hand set at the factory.

In laying these mains we grade a ditch with almost as much care as though we were laying low pressure mains. At the time of laying, the couplings are unscrewed and liberally coated with red lead, then reversed, and in practically 70 per cent of the connections we find that we are able to utilize all of the thread on the pipe, thus making our connections good from a friction standpoint as well as a mechanical standpoint. We have a large, portable air compressor with which we fill the mains with air up to 100 pounds pressure. Each joint is then carefully tested with soap suds, and we have reason to believe that our lines are as well laid as possible.

We insert expansion joints in the line at various points, such as river crossings, corners at the end of long sweeps, etc., and also provide the line liberally with valves.

Our expansion joints and valves are set in concrete boxes with cast iron man hole covers, similar in design to those used in conduit work in cities, but smaller in size.

Suburban gas distribution is growing in importance each year, especially in Southern California, where the trend seems to be toward ten-acre ranches. In our Southern Division, supplying the cities of Santa Ana, Anaheim, Orange and Fullerton, we have a generating plant at Santa Ana, serving the entire district.

The high pressure trunk line is 4 in. in diameter and is 12 miles long, and carries gas under a pressure varying from 10 to 20 pounds.

This territory included a population of about 25,000 people, formerly supplied from four plants. This particular group of towns offers an excellent opportunity for this class of work, and it might be termed "Intensive Suburban Distribution."

From Santa Ana, with a population of 10,000, it is a distance of three miles to Orange, with a population of 5000; from Orange it is a distance of four miles to Anaheim, with a population of 5500; from Anaheim it is a distance of three miles to Fullerton, with a population of 3500; while along the road traversed by the high pressure trunk line, there are about 20 houses to the mile.

The gas for this section is manufactured at Santa Ana and compressed through receiving tanks to a high pressure trunk line, which is 4 inches in diameter the entire distance.

The eventual plan on this particular group is to extend the line a further distance of thirteen miles to [illegible].

The high pressure line, as it passes through Santa Ana, is utilized to serve certain sections by district regulators.

At the plants which have been shut down, the holders are kept full and held in reserve in case of interruption of service furnished by the high pressure trunk lines, small compressor plants being maintained to utilize the gas stored.

In all high pressure work the installation must be made with the greatest care and with the utmost precaution, as small breaks, such as a plowed up service, may result in a great deal of loss of gas before the pressure can be shut off.

The development of high pressure gas distribution has resulted in operating economies, in securing better pressure [illegible], and has enabled us to serve customers not [illegible] available.

OUR INVESTIGATING DEPARTMENT.

BY C. M. HUNT.[1]

The investigating department of a public service corporation of to-day is not the chamber of horrors it was some three years ago. The public have rights which we gladly respect. The policy of this department is to shape its attitude as regards the public so that the patron is bound to feel that by simply calling attention to a real or imaginary wrong it will receive prompt attention.

I feel that the patron making a complaint is honest in the belief that a wrong exists which, from his point of view, needs immediate attention from this department, and we attempt to give that complaint immediate attention, and a full and complete investigation is had. I cannot bring myself to feel that even though the claim be an insignificant one it can be passed without a full and complete investigation, as it is the little things that are noticed in corporations and, odd as it may seem, I do not believe that the general public intends to impose upon this department.

Special Room Set Aside for Investigating Department.

Now, as an investigator, I do not take the position that I am at liberty to make a patron feel as if he or she were upon the witness stand when stating his or her complaint, and that I or the investigator were taking him through a strenuous cross examination in the effort to have him admit that his claim to poor service, or even a disputed account, or the like, was not well based.

I believe, too, that the matter of the mode of transmission of either gas or electricity for their burners and lamps should be fully understood by them, and I have always taken pleasure in making full and complete explanations whenever a patron showed an interest and made inquiry in reference thereto.

I feel too, that the matter of a patron being able to read his own meter is of importance, and the mechanism of a meter should not be shrouded in mystery, but the contrary. A patron should be given full insight into the the same and I for one attempt to instruct them in meter reading and for that purpose have prepared devices whereby they may take up the study of meter reading and, so far, have been successful, and now among our patrons find many housewives who as consumers are able to read their gas and electric meters. Heretofore a meter was looked upon as a puzzle made only for the purpose of defrauding the public and not for the purpose of showing its consumption. Along that line, that is for the instruction of the general public, we have installed in the investigating department of this company, not alone for our own edification, but, as I have said, for the benefit of the public, the following equipment:

A gas meter with glass front and back, showing its complete mechanism. To this meter we have attached one ordinary open gas jet and a mantle burner. Between the meter and the burner are gauges showing the consumption per hour, thus enabling us to show the customer the difference in the amount of gas consumed on these burners, and it is surprising to know that many disputed bills have been settled satisfactorily by this comparison.

We have also a Jones jet photometer showing the candle-power of our gas, also a water column pressure gauge which shows our gas pressure.

We also have an electric recording volt meter, a regular type I electric meter with glass front showing mechanism of same.

To bring about comparisons in electric lighting, we have bars upon which are placed electric lights, the upper bar showing the various sizes of carbon lamps and the bar underneath showing the various sizes of Mazda lamps. To this we have connected a watt indicating meter with a special dial which indicates the amount of current consumed per hour on any of the lamps displayed on the bars spoken of. This special dial is based upon the rate upon which we sell our electric current; namely, 10 cents per kilowatt hour.

Along these lines, I should like to say that this device, as well as the demonstrating gas meter has done as much or more to adjust claims of dissatisfied customers than all the talker or writer might do, as it is self-explanatory and demonstrates to the customer what words have failed to do.

I have attached photographs showing views of the interior of this office.

I also append a copy of our investigating order. The body of this order covers all possible complaints as well as the mode of investigating the same, by whom, at what time, time consumed, and various other important items. At the bottom of the order you will note report of workmen, showing time of receipt of order by him, when executed and when returned to this office. On the reverse side you will note a detailed report, not only showing the conditions as he finds them, but the equipment and appliances of the house and also any suggestions which he might make which would better the service.

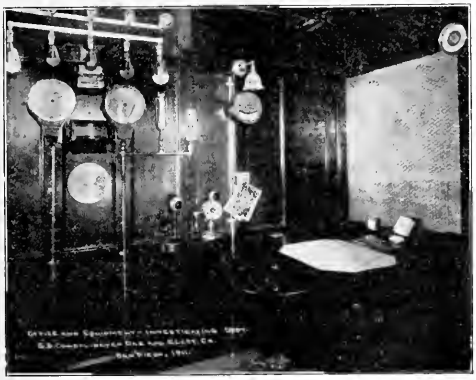
A report of this kind returned to this office puts

[1]Manager San Diego Consolidated Gas & Electric Co.

us in direct touch with the facts concerning the complaint and at the same time aids in our load record.

After installing this system of investigation and giving the same due and thorough trial our complaints have decreased very materially as is shown by the following statement: In the last two years the complaints have fallen off from 5 per cent down to ½ of 1 per cent of our customers and this too, notwithstanding the fact that our increase on meter sets has raised from six thousand to twelve thousand.

It must be borne in mind that in this department we have to deal with complaints of high bills, poor service, gas leaks, setting or removing meters, re-reading of meters, opening and closing of accounts, testing meters and answering by letter of every complaint entered in this office after the order which has been issued thereupon is returned to the writer. Now this letter explains to the customer just what the conditions were as reported, and it is not a stereotyped letter, but deals with each individual complaint and is signed in person by the writer.



Emergency Instruments in Investigating Department.

In order to meet the demands and take care of the orders that are entered in this office we have a force of day men as well as night men. The night force on the electric side consists of one night man mounted on a motor cycle and one with an automobile. For the gas we have two gas night men with steam automobile, equipped with all necessary tools as well as 100 feet of hose which can be utilized in case the service line is choked. These men also carry extra meters. Their office is equipped with a complete telephone system, thus putting the public in touch with them at all times. These men make their report before going off duty in the morning, thus putting this office in touch with what transpired during the night.

In conclusion I wish to say that it is the effort of this department to give the public not only satisfaction but perfect service, and that it is not only the method and manner in which this is handled and what is said as much as the way in which it is said and the courteous treatment that our patrons receive that is the primary cause of our success—if we are successful—our precept being that courtesy is a cheap commodity, and that we attempt to be men among men.

PRIMER OF APPLIED THERMODYNAMICS.

Sixth Lecture.

Boiler Efficiency and Factor of Evaporation.

In our last lecture we looked somewhat into the theory of perfect gases, and found the laws under which they act and the consequent engineering computations which can be made. Before entering deeper into considerations of work and other thermodynamic relationships, it will be well for us to go back again to our studies in combustion, and still further see how the heat is made use of after combustion takes place. We have found that where 1 lb. of pure carbon is converted into carbon dioxide, 14,600 B.t.u. are liberated. and in the formation of carbon monoxide only 4450 B.t.u are given out. Hence if

W = weight of gas formed per lb. of carbon,

K = mean specific heat,

$T - t$ = elevation of temperature produced, then

$$T - t = \frac{14{,}600}{W K} \text{ for combustion to carbon dioxide, and}$$

$$T - t = \frac{4450}{W K} \text{ for combustion to carbon monoxide.}$$

Hence it is evident that if too much air is supplied to the furnace, although all of the carbon may be burned as carbon dioxide, yet the cooling effect brought about by enlarging W will reduce the temperature. On the other hand, when too little air is admitted, carbon monoxide is formed instead of carbon dioxide, and again the temperature is not only lowered but much heating value of the coal or fuel goes out of the stack. The amount of air theoretically required to burn one pound of coal is

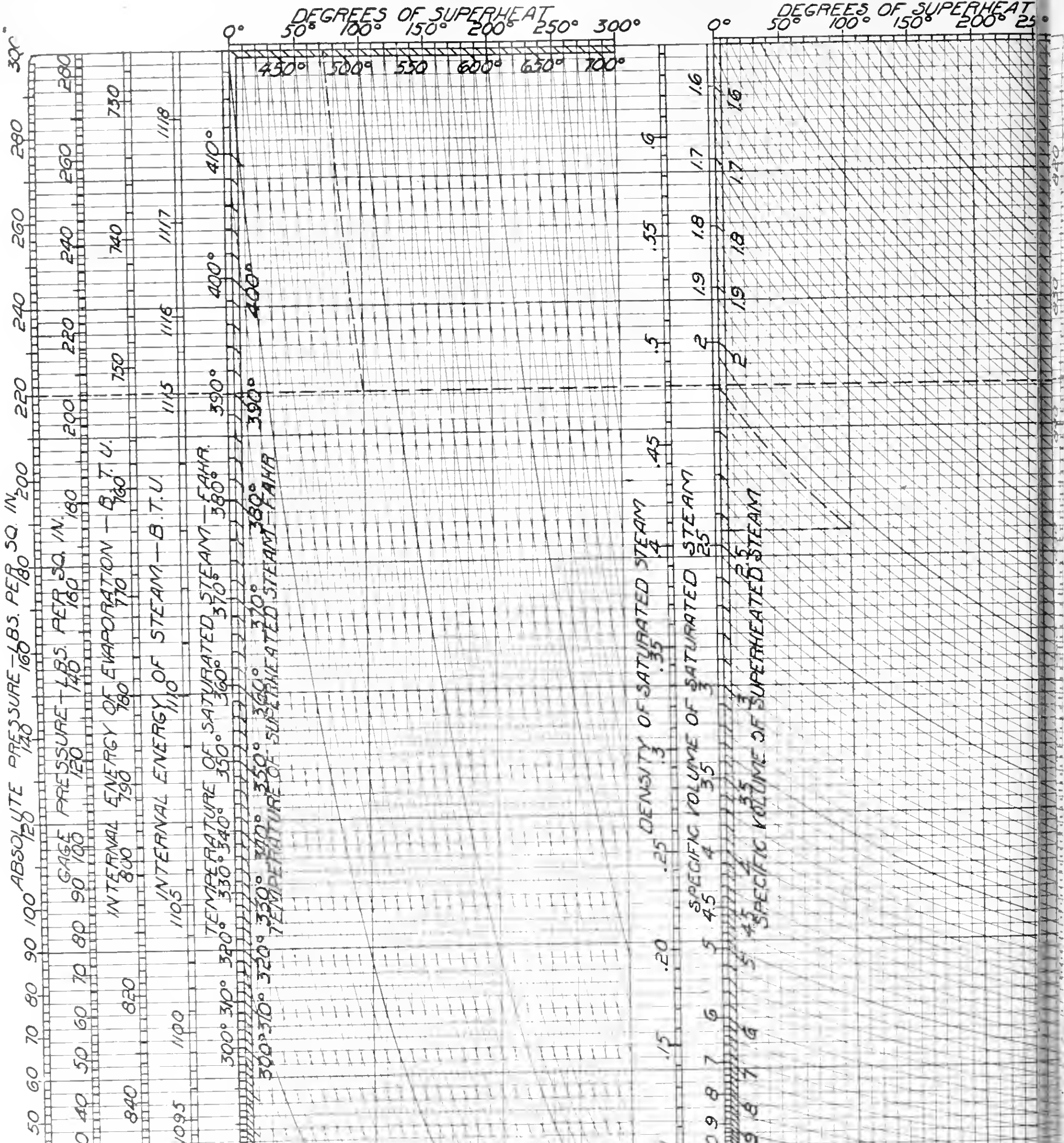
$$11.52\,C + 34.56\,\left(H - \frac{O}{8}\right) + 4.32\,S,$$

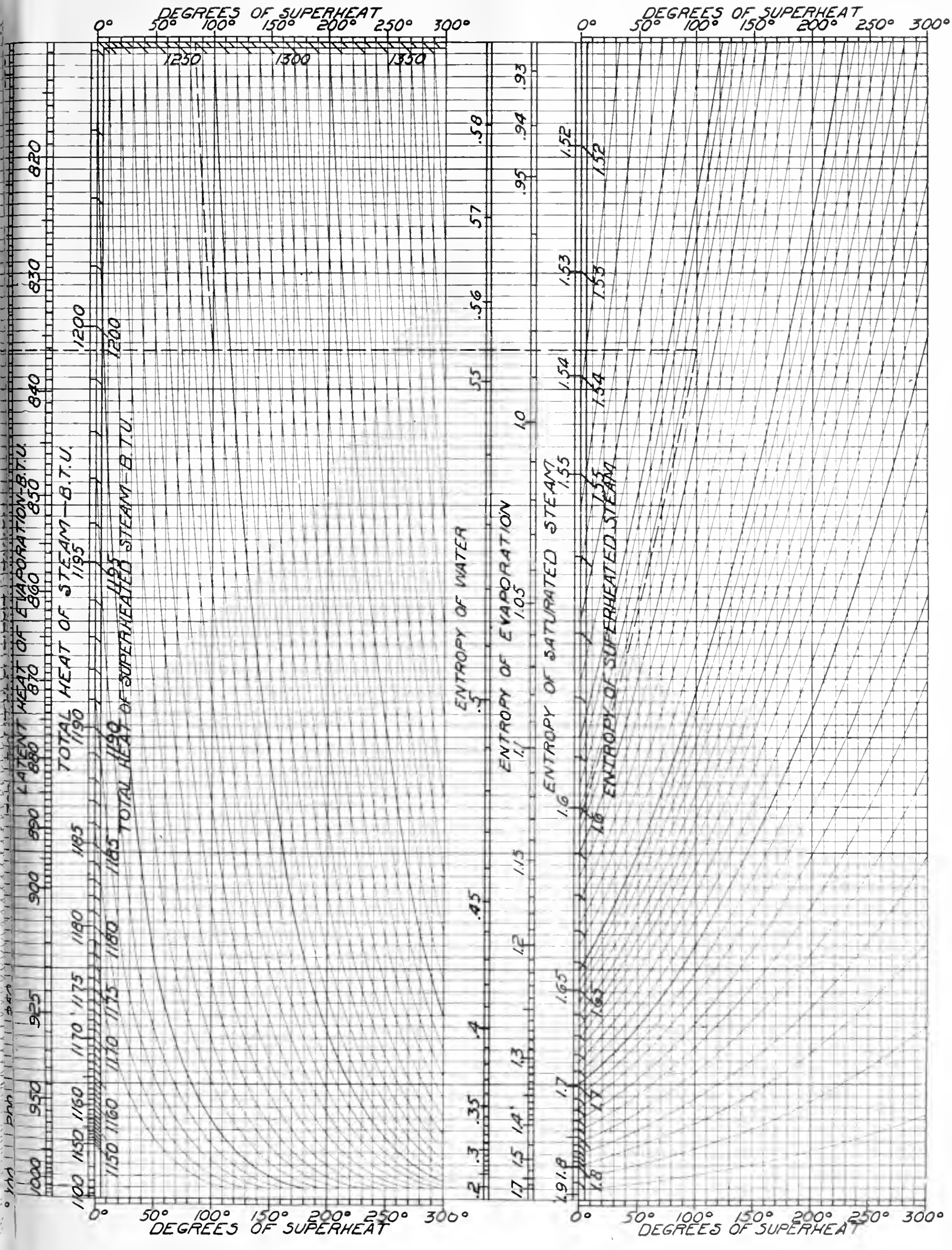
where C, H, O, and S are the proportionate parts by analysis of the carbon, hydrogen, oxygen, and sulphur in the fuel.

The mechanical device made use of to supply a proper quantity of air for combustion and to transfer the heat so formed into evaporated water or steam it known as a boiler. It is not the purpose of this lecture to go into the makeup of the modern boiler. If the reader desires to refresh his mind, a description of an efficiency type of boiler will be found elsewhere in the pages of this Journal in an account of a test performed on a Parker boiler by R. F. Chevalier, consulting engineer.

Boilers are usually rated by the number of pounds of water they can evaporate per hour. In 1876 it was found that a one-horse power engine required, as a rule, a boiler of such capacity as could evaporate 34½ lb. of water per hour from 212° F. into steam at 212° F. In our last lecture we found that by experiment it has been proven that it requires 970.4 B.t.u. to evaporate

[1] A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.


DEGREES OF SUPERHEAT
ABSOLUTE PRESSURE—LBS. PER SQ. IN.
GAGE PRESSURE—LBS. PER SQ. IN.
INTERNAL ENERGY OF EVAPORATION—B.T.U.
INTERNAL ENERGY OF STEAM—B.T.U.
TEMPERATURE OF SATURATED STEAM—FAHR.
TEMPERATURE OF SUPERHEATED STEAM—FAHR.
DENSITY OF SATURATED STEAM
SPECIFIC VOLUME OF SATURATED STEAM
SPECIFIC VOLUME OF SUPERHEATED STEAM
DEGREES OF SUPERHEAT



GRAPHIC REPRESENTATION OF THE PROPERTIES OF SATURATED AND SUPERHEATED STEAM.

(To Accompany Lectures on "Primer of Applied Thermodynamics.")

Based upon data from Marks and Davis's Steam Tables.

This chart gives the approximate numerical value and shows the relations existing between the various properties. The dotted line clearly indicates the method to use.

1 lb. of water from 212° F. into saturated steam at 212° F. We have also found that one B.t.u. represents 778 ft. lb. of energy. Hence,

1 boiler horsepower = 34.5 × 970.4 × 778 = 26,-000,000 ft. lb. per hr.

According to our usual mechanical definition, one horsepower is such a power as can perform 33,000 ft. lb. of work per minute or 1,980,000 ft. lb. per hour. By comparing this with the boiler horsepower above defined, it is seen that in reality one boiler horsepower is equivalent to about 13 mechanical horsepower. In a word, in 1876 when this definition was first made, there was the enormous loss of 13 times the energy formed in the boiler to that actually given out from the steam engine. Efficiencies have increased greatly since then, but even with all our modern refinements, we shall later find that a great gap still exists, due to certain thermodynamic laws.

A modern boiler does not simply perform the function of evaporating water from 212° F. to steam at 212° F. As we have previously seen, it is necessary first to heat the water to the evaporation point, which, in modern practice, is far different from 212° F. After heating it to the evaporation or boiling point, it is then necessary to supply the heat of vaporization, which is in general different from the 970.4 B.t.u. required at 212° F. at atmospheric pressure. Then, again, if our boiler has a superheater, it is necessary to supply heat per lb. of steam in an amount equal to the product of the specific heat and the range of temperature of superheat. Therefore in order to compare boilers, one with the other, it is necessary to reduce their water evaporating qualities to a standard, and this standard is the quantitative amount of water that the same amount of heat would evaporate into steam were the water all at 212° F. and the steam so formed remain at 212° F. The ratio of the total quantity of heat absorbed by the steam per pound from the time it enters the boiler as feed water to that quantity of heat necessary to evaporate water from 212° F. to steam at 212° F. is called the factor of evaporation, or

$$\text{factor of evaporation} = \frac{H - h}{970.4}$$

H = total heat in steam and liquid above 32° F.

h = total heat in feed water above 32° F.

As an example of how to compute this factor of evaporation in any given case let us take the test of the Parker boiler above referred to as appearing elsewhere in this issue of the Journal. It is seen that in the test of Jan. 5, 1911, the temperature of the feed water entering the boiler was 165° F. that the pressure gauge read 178.5 lb., and that the final temperature of the superheated steam was 539° F.

By reference to the diagram of properties of steam presented herewith, let us find the properties of steam for this particular case. Let us begin at the upper heading entitled "Absolute Pressure." As our pressure is in lbs. per sq. in. gauge, immediately beneath this heading we find 178.5 lb. pressure per sq. in. Following a vertical line, we find that corresponding to 178.5 lb. pressure per sq. in. gauge, the absolute pressure is 193.2, and the temperature of the saturated steam is 379°. Hence the superheat is 539 — 379 = 160°. Dropping further down along the vertical line, we find the latent heat of the saturated steam is 847.2 B.t.u., and the total heat is 1197.2 B.t.u. Still further down along the line vertically, we find an intersection of our vertical line with a horizontal line marked 160° for superheat. Following to the right between the curved lines, we finally read on the extreme right, 1288 B.t.u. for the total heat of the superheated steam under the conditions of this test. This is remarkably accurate for the purposes of our present computation. Since the feed water is at 165° F., its liquid heat is 165 — 32, or 133 B.t.u. Hence for our factor of evaporation in this illustration, we have

$$\text{factor of evaporation} = \frac{H - h}{970.4}$$

$$= \frac{1288 - 133}{970.4} = \frac{1155}{970.4} = 1.19$$

Since this boiler during eight hours evaporated 156,974 lb. from 165° F. into steam at 539° F. superheated 160°, the same boiler evaporating water from 212° F. into steam at 212° F., would evaporate

$$156{,}974 \times 1.19 = 186{,}799 \text{ lb.}$$

In one hour it would evaporate

$$\frac{186{,}799}{8} = 23{,}350$$

Hence its horsepower according to our definition is

$$\frac{23{,}350}{34.5} = 676.7$$

Let us next compute the efficiency.

During the eight hour test, 11,699 lb. of oil were consumed, and by analysis the oil gave out 18,513 B.t.u for every lb. consumed. Hence total B.t.u. given out by fuel

$$= 11{,}699 \times 18{,}513$$

During the eight hrs. test 156,974 lb. of steam were formed at 539° F., and for every pound so formed, we have found it required 1155 B.t.u. Hence total B.t.u. put into the steam

$$= 156{,}974 \times 1155.$$

Efficiency is defined as the ratio of energy transmitted to the steam to the total energy given out by the fuel. Hence the efficiency for this boiler is

$$\frac{156{,}974 \times 1155}{11{,}699 \times 18{,}513} = 83.6\%.$$

The student following this series of lectures is requested to keep the steam chart embodied in this lecture, for it will be found exceedingly useful not only in solution of such problems of the boiler as illustrated above, but for many other applications in succeeding lectures.

Should the student desire to compute the total heat of superheated steam without the use of a chart he should proceed in the following manner. In a previous lecture we have found that the total heat of saturated steam is

$$H = 1150.4 + 0.3745 \ (t - 212) - 0.000550 \ (t - 212)^2$$

In case the steam is superheated it is necessary for us to add an additional amount of heat to this formula equal to the product of the mean specific heat of superheated steam for the range under consideration and the number of degrees of superheat. Hence our formula becomes

$$H_s = 1150.4 + 0.3745 \ (t - 212) - 0.000550 \ (t - 212)^2 + k \ (T - t)$$

where H_s = total heat of superheated steam,

t = temperature of saturated steam at boiler pressure,

T = temperature of superheated steam,

k = mean specific heat of superheated steam.

The only quantity that is variable and difficult to arrive at in the above is the proper value of k. Formerly it was thought that k was a constant having a value of 0.48. Recent experiments have shown this to be far from the truth. The following table taken from Peabody's Steam and Entropy Tables represents results compiled from the exhaustive tests of Knoblanch and Jakob, from which the value of k is easily gotten.

Let us find the total heat of superheated steam in the problem above solved by use of the diagrams. Since the abs. pressure in lb. per in. was 193.2, I look under column headed 14 and find 199.1, which is as near a value as I can find without interpolation. Looking vertically downward I find 0.55 at the intersection of a horizontal line from 572° F. superheat, which is the temperature nearest the value of the test.

Hence I proceed as follows:

$$t = 379, \ T = 539, \ k = 0.55$$

$$\therefore H_s = 1150.4 + 0.3745 \ (379 - 212) - 0.00055 \ (379 - 212)^2 + 0.55 \ (539 - 379)$$

$$= 1285.6 \text{ B.t.u. per lb. of superheated steam.}$$

This value is seen to differ by only ¼ of one per cent from the value picked from the chart. By interpretation in the table of superheated steam the value of k is more nearly .56 than .55. Hence it is seen that the two values even more nearly conform.

But one equation now remains and we can be independent of steam tables if we so desire. We need some empiracal rule by which we can compute the temperature of saturated steam when the pressure is given. In Power, March 8, 1910, we find that

$$t = 200 \ p^{1/6} - 101$$

in which t is in Fahrenheit degrees and p the pressure in lb. per sq. in. From this let us confirm the above relation that 178.5 gauge or 193.2 absolute pressure exists when saturated steam is at 379° F. Substituting

$$t = 200 \ (193.2)^{1/6} - 101 = 200 \times 2.405 - 101 = 380° \text{ F.}$$

The correct temp. is 379° H. Hence there is an error of only about ¼ of one per cent.

A diagram supplying the thus far missing information of liquid heat of steam will appear in the next lecture, thus completing all tables necessary in steam computation.

Thermotwisters.

1. In the test of the Parker boiler found elsewhere in these columns during a ten-hour run 180,240 lb. of water were evaporated from a feed water temperature of 123.4° F. to superheated steam at 561.2° F., the boiler pressure being 179.7 lb. per in. (gauge). What is the factor of evaporation?

2. From the data given in problem 1, compute the horsepower rating of the boiler.

3. During the same test mentioned in problem 1, 14,093 lb. of oil were consumed. The oil has 0.6% water. The calorific value of the dry oil per lb. is 18,681 B.t.u. by analysis, show that the efficiency of the boiler was 83.13% under the test referred to.

4. A pressure gauge reads 179.7 lb. per sq. in. What is the temperature of the saturated steam in the boiler. Compute by the empiracal formula given above.

Soloution of Thermotwisters—Third Lecture.

1. California oil has a specific gravity of 0.92 and it is found to contain 5% moisture. Apply Le Conte's formula and compute the calorific value per pound of oil.

We must first compute what specific gravity the oil would have were no water present.

Let x = specific gravity of oil free from water.

Then, $.05 + .95 x = .92$

$.95 x = .87$

or $x = .916$.

Relationship on Beaume scale and specific gravity is

$$B = \frac{140}{\text{sp. gr.}} - 130 \text{ or } B = \frac{140}{.916} - 130 = 22.8$$

Since B.t.u. per lb. of oil = 17680 + 60 B, we have

Calorific value of oil = 17680 + 60 × 22.8 = 19,048 B.t.u. Ans.

2. A sample of Pocahontas coal is found by chemical analysis to contain the following ingredients:

Carbon	84.87
Hydrogen	4.20
Oxygen	2.84
Nitrogen	0.85
Sulphur	0.59
Ash	5.89
Moisture	0.76
	100.00

Compute by Dulong's formula the calorific value of the coal per pound of fuel.

Substituting in Dulong's formula we have

$$\text{Heating value of fuel per lb.} = 14{,}600 \text{ C} + 62{,}000 \left(\text{H} - \frac{0}{8}\right) + 4000 \text{ S}$$

$$= 14{,}600 \times .8487 + 62{,}000 \left(.0420 - \frac{.0284}{8}\right) + 4000 \times .0059 = 14{,}790$$

Ans.

MEAN SPECIFIC HEAT OF SUPERHEATED STEAM.

p Kg. per Sq Cm. abs.		1	2	4	6	8	10	12	14	16	18	20 abs
p lbs. per Sq. In. abs		14.2	28.4	56.9	85.3	113.8°	142.2	170.6	199.1	227.5	256.0	284.4 abs.
ts Cent.		99°	120°	143°	158°	169°	179°	187°	194°	200°	206°	211° sat.
ts Fahr.		210°	248°	289°	316°	336°	350°	368°	381°	392°	403°	412° sat.
212°	100°	0.463	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
302°	150°	0.462	0.478	0.515	.....	.....	.....	.....	.....	.....	.....	.....
392°	200°	0.462	0.475	0.502	0.530	0.560	0.597	0.635	0.677	.....	.....	.....
482°	250°	0.463	0.474	0.495	0.514	0.532	0.552	0.570	0.588	0.609	0.635	0.664
572°	300°	0.464	0.475	0.492	0.505	0.517	0.530	0.541	0.550	0.561	0.572	0.585
662°	350°	0.468	0.477	0.492	0.503	0.512	0.522	0.529	0.536	0.543	0.550	0.557
752°	400°	0.473	0.481	0.494	0.504	0.512	0.520	0.526	0.531	0.537	0.542	0.547

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CONTENTS

Boiler Efficiencies

An efficiency of 83% is remarkable as boiler tests run. Elsewhere in these columns will be found the beginning of an article dealing with a boiler test performed during the year at the Fruitvale station of the Southern Pacific Company's plant in Oakland. The actual test results will be published in the next issue of the Journal. The efficiency as found from the first test proved to be 83.6%, while a test performed some weeks later showed an efficiency of 83.13%. Both are remarkable results and show the wonderful degree of perfection modern boiler design can accomplish.

During the test, data were taken to determine the weight of steam required in atomization of the oil per pound of oil consumed. It is to be hoped many other similar tests may be performed in the near future along the same lines, in order that considerable data may be amassed relative to steam used in atomization. A saving of steam at the burner means just so much energy retained in the boiler. The economic saving of this steam is not usually considered in boiler efficiencies, but it is evident that a saving in the use of steam for atomization means the raising of the efficiency of the boiler so far as dollars and cents are concerned for costs in generating power.

California's Proposed Amendment No. 47.

It takes very little stretch of imagination for us to form a mental picture of the good old days of yore, when our forefathers lived in caves in the mountains, and, by means of brute prowess of the one over the other, kept under control not only the worldly possessions of a neighbor, but even his very physical life and happiness. As a rule, the man of great physical strength must have held sway over the brother of smaller stature. Undoubtedly this state of affairs existed until the smaller brother combined with another small brother, so that by the united effort of the two, the larger brother was made the vassal. And so the conditions of society were gradually built up until groups of individuals formed combinations against other groups, and the stronger held sway over the weaker group.

Finally, for the good of society, it was recognized that property and vested rights of the individual must be protected against all intruders, and, by means of the body politic of the state, society so forced this idea upon the components of a government that it has become impregnated in the very life of all self-ruling peoples. As a fundamental axiom or postulate of the human makeup, however, it must be recognized that what society has at one time decrêed society may at some future period after long stages of evolution entirely reverse.

We say we are free, that we have liberties which society cannot take from us. We are free, and we have liberties which society cannot take from us, as long as society so rules. For instance, society may rule to-day that a certain class of undesirable individuals shall be put to death, while to-morrow, society may rule that no individuals shall suffer capital punishment.

The unprecedented industrial development of the

world during the past twenty-five years has forced upon the thinking public new ideas which would have been so startling twenty-five years ago that then they would have been regarded as dangerously revolutionary in character. The general good and well-being of human society, however, has demanded it. The fallacious idea that property interests and property rights are, like the powers of medieval monarchs, of divine right, has been seriously questioned by thinking men, who control the final decrees and dictates of society. The rise of combinations, strong enough in their power to shake and shape the destinies of nations, has added fuel to the thinking mind. The trend of industrial affairs and of our modern mode of living, however, has been the critical factor to ripen the fruits of this thought. The growth of populous cities congested into small areas, necessitating for the very breath of life, a perfect and smooth-running industrial machinery, makes the issue in some cases a life and death struggle. Close down our railways, shut off our electric power generation, demolish or imperfectly operate our water supply for a brief month, and we defy anyone to foretell the outcome. So deeply have the transportation facilities, the water service, the light and heat service, and the thousand daily human necessities of modern life become impregnated in our daily life, the very well-being of human society is at stake.

There is a realization of the great human interests at issue, and throughout our nation is heard a popular demand, and a rightful demand, too, for a supervision of the great human necessities. Like all other great movements, its first days of conception were stormy ones, with the demands of society pitted on the one side crying for unfair and impossible legislation, and the corporate interests on the other side, ugly and unapproachable. We have now arrived at the second period—a period of results and understandings accomplished.

In the older States, where fair-minded and reasonable men have controlled the actions of the Public Service Commission, the public, including the corporation sentiment, is overwhelmingly in favor of the commission form of control for public service corporations. It is an attribute of the thinking human being, distinguishing him from other members of the vertebrate family, the ox, the cow, the mule and the ass, that in his calm, self-possessed moods, he can deal out absolute justice to his fellow men.

The agitation now going on among the voters of the great State of California concerning certain constitutional amendments soon to be decided at the polls, is worthy of more than passing mention. The details of amendment No. 47 can be found elsewhere in the columns of this journal. We believe in proper control by a public service commission. We believe that this control should be specific, direct, and so worded that no misconstruction is possible, but, above all, we believe that when once granted, municipalities as well as private corporations should be brought within the fold of supervision.

The amendment, as proposed, has certain ugly features in its makeup. From the days that Virgil sang his pretty song in the Aeneid, men have known and understood that "variabile et mutabile mulier est"—fickle and changeable is the mind of woman. But read what exquisite fickleness and changeableness it is proposed to allow the municipalities of California:

Senate Constitutional Amendment No. 47, a resolution proposing to the people of the State of California an amendment to section twenty-three of article twelve of the constitution of the State of California, to confer upon the railroad commission power and jurisdiction to regulate and control the business of furnishing certain commodities and performing certain services to or for the public.

[Adopted March 28, 1911]

The legislature, of the State of California, at its regular session, commencing on the second day of January, one thousand nine hundred and eleven, two-thirds of all the members elected to each of the two houses of said legislature voting in favor thereof, hereby proposes to the people of the State of California that section twenty-three of article twelve of the constitution of the State of California be amended so as to read as follows:

Sec. 23. Every private corporation, and every individual or association of individuals, owning, operating, managing, or controlling any commercial railroad, interurban railroad, street railroad, canal, pipe line, plant, or equipment, or any part of such railroad, canal, pipe line, plant or equipment within this State, for the transportation or conveyance of passengers, or express matter, or freight of any kind, including crude oil, or for the transmission of telephone or telegraph messages, or for the production, generation, transmission delivery or furnishing of heat light, water or power or for the furnishing of storage or wharfage facilities, either directly or indirectly, to or for the public, and every common carrier, is hereby declared to be a public utility subject to such control and regulation by the railroad commission as may be provided by the legislature, and every class of private corporations, individuals, or associations of individuals hereafter declared by the legislature to be public utilities shall likewise be subject to such control and regulation.

The railroad commission shall have and exercise such power and jurisdiction to supervise and regulate public utilites, in the State of California, and to fix the rates to be charged for commodities furnished, or services rendered by public utilities as shall be conferred upon it by the legislature, and the right of the legislature to confer powers upon the railroad commission respecting public utilities is hereby declared to be plenary and to be unlimited by any provision of this constitution.

From and after the passage by the legislature of laws conferring powers upon the railroad commission respecting public utilities, all powers respecting such public utilities vested in boards of supervisors, or municipal councils, or other governing bodies of the several counties, cities and counties, cities and towns, in this State, or in any commission created by law and existing at the time of the passage of such laws, shall cease so far as such powers shall conflict with the powers so conferred upon the railroad commission; provided, however, that this section shall not affect such powers of control over any public utility vested in any city and county, or incorporated city or town as, at an election to be held pursuant to laws to be passed hereafter by the legislature, a majority of the qualified electors voting thereon of such city and county, or incorporated city or town, shall vote to retain, and until such election such powers shall continue unimpaired; but if the vote so taken shall not favor the continuation of such powers they shall thereafter vest in the railroad commission as provided by law; and provided, further that where any such city and county or incorporated city or town shall have elected to continue any powers respecting public utilities. It may, by vote of a majority of its qualified electors voting thereon, thereafter surrender such powers to the railroad commission in the manner to be prescribed by the legislature; or if such municipal corporation shall have surrendered any powers to the railroad commission, it may, by like vote, thereafter reinvest itself with such power.

Nothing in this section shall be construed as a limitation upon any power conferred upon the railroad commission by any provision of this constitution now existing or adopted concurrently herewith.

The good of California demands commission regulation. Let us make this regulation uniform and secure. An amendment that allows a municipality to be regulated of its own free will by a commission to-day and, should the shoes pinch on to-morrow, to withdraw within itself, is not only unfair to our public service corporations, but a danger to stability in the government of our commonwealth.

PERSONALS.

Hal. Lauritzen, western field manager for the Holophane Company, is at San Francisco.

P. C. Butte, manager of the Butte Engineering and Construction Company of San Francisco, is at Vancouver, B. C.

H. E. Sanderson, Pacific Coast manager for the Bryant Electric Company, is at Los Angeles.

W. L. Goodwin, vice-president of the Pacific States Electric Company, is at Los Angeles on a business trip.

Charles L. Turner has been made assistant manager of the Los Angeles house of the American Ever Ready Company.

H. F. Froesch of the Federal Electric Sign Company, died at San Francisco on September 27th. Interment will be at Chicago.

Lee C. Moore of Pittsburg, Pa., builder of transmission line towers, is visiting the Pacific Coast, now being in Los Angeles.

H. Bostwick, secretary to John A. Britton of the Pacific Gas & Electric Company, is on his way to Honolulu for a two weeks' vacation.

J. W. Swaren is conducting a department of the Town and Country Journal of San Francisco devoted to the application of power to farming.

J. H. Clover has resigned his connection with the Holophane Company to become sales engineer with the Pacific States Electric Company.

J. A. Vandergrift, manager of the Oakland warehouse of the National Electric Lamp Association, has returned from a trip through the Northwest.

J. P. Edwards, the electrical and mechanical engineer of the Northern Electrical Railway Company, of Chico, was at San Francisco during the past week.

Frank H. Morgan, an electrical engineer of Liverpool, England, has been spending a few days at San Francisco, while looking over the principal electric transmission systems of this country.

A. L. Collins, formerly assistant engineer with the Sacramento Valley Irrigation Company at Willows, Cal., is now with Duryea, Haehl & Gilman, consulting engineers, at San Francisco.

John S. Baker, Pacific Coast district manager of Crocker-Wheeler Company, has returned to San Francisco, after visiting Los Angeles on business connected with a hydroelectric project.

John L. McCandless, president of the Hawaiian Electric Company, Ltd., of Honolulu, passed through San Francisco during the past week, on his way from the Islands to the Northwest.

S. E. Doane, chief engineer of the National Electric Lamp Association, is making a Pacific Coast trip. He spent the past week in the Northwest and after visiting Southern California will return East.

J. P. Bradner was married at San Francisco on September 27 to Mrs. M. L. Luce. Mr. Bradner's many friends among the engineers and power companies of the Coast are offering him their most sincere congratulations.

Malcolm McIntyre, general superintendent of the San Francisco, Vallejo & Napa Valley Railway Company, and George A. Hearn, the company's chief electrician, were recent arrivals at San Francisco from Napa.

John Finnegan, the purchasing agent of the United Railroads of San Francisco, will attend the National Street Railway Convention at Atlantic City next week. S. K. Colby, of Pierson, Roeding & Co., will also be in attendance.

J. B. Ingersoll recently resigned as chief engineer of the Spokane & Inland Empire Railroad Company at Spokane, Wash., to accept a similar position with the British Columbia Electric Railway Company at Vancouver, B. C.

Chas. E. Hearn, city sales manager of the Electric Appliance Company, is retiring from that office to represent the company in Arizona, New Mexico and Southern California. Mr. A. Meinema will succeed Mr. Hearn as city sales manager.

John Coffee Hays, general manager of the Mt. Whitney Power Company, is again at San Francisco after visiting Visalia in connection with the closing of contracts for additional hydroelectric equipment at one of the company's power stations.

Garnett Young, general manager of the Telephone Equipment Company of California has been entertaining a number of the company's sales managers at his offices in the Security Building during the past week on the occasion of their annual meeting.

W. S. Heger, formerly representing the Allis-Chalmers Company, at San Francisco, returned to his home in Marin county a few days ago after an enjoyable Eastern trip during which he renewed old acquaintanceships at Milwaukee and in Delaware.

Earle G. Alexander, who has been connected with the sales department of the California Electrical Construction Company, will shortly take charge of the new electrical supply house, which is to be established at 633 Howard street by the Larbeer Electrical Supply Company of Los Angeles.

F. J. Cram, sales manager of the Electric Appliance Company of San Francisco, will leave for Chicago next week and will spend a month in visiting the various factories represented. He will attend the coming Jovian Congress at Denver, October 16, 17 and 18, while on his way East.

Frank G. Drum, president of the Pacific Gas and Electric Company, has returned to San Francisco after spending some days at New York. He does not officially confirm the rumors that negotiations are in progress for the absorbing of the Great Western Power Company and the Sierra and San Francisco Power Company.

C. W. Burkett, electrical engineer for the Pacific States Telephone Company, very entertainingly supplemented Max Thelen's address on Public Service Commissions at the recent San Francisco Branch meeting of the A. I. E. E., by giving some personal experiences of his pleasant past relationship with the Public Service Commission of Wisconsin.

R. E. Starkweather, with F. G. Baum & Co., has returned to San Francisco, after looking over the electric power transmission field around San Bernardino. The D. A. Chappell interests are preparing to extend their lines from Bishop Creek into that territory, and the Edison Electric of Los Angeles is contemplating a San Bernardino extension from the south.

C. E. Johnson, who has been sales manager of the American Ever Ready Company's San Francisco factory for some time, is now in the Northwestern territory, his place being filled temporarily by F. E. Blanchfield. The latter has been ill during the past year, but expects soon to be able to return to the management of the Northwest branch of the company at Seattle.

F. L. G. Knox, consulting electrical engineer for W. P. Hamon Company, read a very interesting letter at the recent San Francisco Branch meeting from Gano Dunn, president of the American Institute of Electrical Engineers. The letter was written while Mr. Dunn was en route to the international electrical congress at Turin and assured the San Francisco men of his hearty and earnest co-operation in all endeavors to get an international electrical congress at San Francisco in 1915.

G. C. Noble, consulting engineer and assistant professor of electrical engineering at the University of California, has passed in his resignation to the Regents of the State institution to accept a very flattering offer with the Pacific Gas and Electric Company. Mr. Noble is receiving the sincere congratulations of his many friends.

ELECTRICAL CONTRACTORS' NOTES.

First Vice-President Heilbron of San Diego, reports business fair in his section of the country.

Harry Tittel, manager of the electrical department of the John G. Sutton Co., is spending a few days at Vancouver, where he has a number of jobs.

W. McNally, secretary Pasadena contractors. spent a few Pasadena by the W. A. McNally Company for the sum nicely among the contractors in Pasadena.

A large street lighting contract was recently landed in Pasadena by the W. A. McNally Company for the sum of $15,000. The above figure includes lamp posts and underground wiring (municipal system).

Bill Hanbridge, Jr., small son of the secretary of the State Electrical Contractors' Association, passed away, Saturday, September 30th, after a two weeks' illness caused by getting a nail in his foot while at play in the country. The funeral and interment took place at San Jose during the past week.

TRADE NOTES.

The Wirt Electric Specialty Company of Philadelphia has just issued an attractive pamphlet on "The Dim-a-Lite." The booklet is amusing in its portrayal of human nature.

The Butte Engineering and Supply Company was recently awarded a contract for a special electric crane for use at the Mare Island Navy Yard. It will be a 3-phase high-speed travling crane intended to carry timber into the sawmill connected with the yard.

"Modern Electric Lamp Manufacture and Lighting Economies" was the subject of a joint lecture at Santa Cruz, California, on September 28, by Frank W. Loomis of the Holophane Company, and F. D. Fagan of the General Electric Company. This was given under the auspices of the Chamber of Commerce at the Unique Theatre.

The Pelton Water Wheel Company has taken a contract to build for the Mount Whitney Power Company a Pelton-Francis turbine which is to be direct connected to a General Electric generator and installed in the No. 2 power station near Visalia, replacing three generating units driven by three wheels. The new wheel is rated at 2250 h.p. and will operate under an effective head of 360 feet at 720 r.p.m.

The Chicago, Milwaukee and St. Paul, which is already operating approximately 2000 miles of track by the telephone has recently ordered of the Western Electric Company 75 telephone selectors for use on its Hastings and Dakota Division. Three circuits will be installed, the total mileage being about 390 miles. One circuit will run from Montevideo, Minnesota, to Minneapolis, Minnesota, with a branch from Benton Junction to Farmington Yards. There will be twenty-eight stations on this circuit and the dispatcher will be located at Montevideo. A second circuit will run from Aberdeen, South Dakota, where the dispatcher will be located, to Mobridge, South Dakota, a distance of 98 miles, and will be equipped with twelve stations.

The United States Reclamation Service has recently ordered from the Westinghouse Electric & Mfg. Co., for installation on the Boise Project, Idaho, three 625 k.v.a., 22,000 volt, 3-phase air blast type transformers. The government has installed on this project a hydroelectric power plant for furnishing energy to motor driven pumps used for irrigating purposes. As the irrigation season occupies only the summer months, the plant will be kept in part operation during the winter for the purpose of supplying light to the farmer and the small towns on the project. This company has also recently received a contract from the United States Quartermaster's Department, for furnishing the necessary transformers, wattmeters and switchboards for the Army Post located at Fort Bliss, Texas, and at the Angel Island Recruit Station near San Francisco. The Post is to have an electric lighting system installed, energy being purchased from the local electric power company. The apparatus is for the purpose of distributing, controlling and measuring the current consumed in the various buildings of these army posts.

MEETING NOTICE.

The National Electric Light Association meets in Seattle next June and an electrical exposition will be held in Seattle at that time. Arrangements have been made whereby the Armory will be used for this purpose. Space will be given free of charge to any one of the electrical manufacturers who wish to exhibit. No charge for admission will be made.

The members of the Seattle Section of the American Institute of Electrical Engineers met at dinner at the Arctic Club on the evening of September 16. This being the first meeting after the summer recess, no formal paper was presented. Secretary Whitney reported the business transacted at the Chicago national meeting and Chairman A. A. Miller outlined a comprehensive plan of action for the next year. In all likelihood a Pacific Coast meeting will be held at Seattle about the time of the National Electric Light Association's convention there.

BOOK REVIEWS.

Addresses to Engineering Students. By Waddell & Harrington, consulting engineers. Size 6x9½ inches; 493 pages; clear type, durable binding. Published by Waddell & Harrington of Kansas City, Missouri, and for sale by Technical Book Shop, Rialto Bldg., San Francisco. Price $1.00.

Messrs. Waddell & Harrington, consulting engineers, have added many noted engineering structures to the engineering art, but never a more lasting monument could be erected than this interesting and helpful compilation of addresses to engineering students. Within its covers will be found addresses by such men as Dean J. B. Johnson, Charles W. Eliot Walter C. Kerr, Dugald C. Jackson, Dr. M. E. Cooley, the authors themselves, and a host of others The whole tone of the book is so wholesome, so optimistic, so full of the very juice of life, an engineer, be he young or old, can ill afford not reading it.

Power Plant Testing. By Professor J. A. Moyer. A manual of experimental engineering; size 6x9½ inches; 436 pages; 271 illustrative figures; cloth binding. Published by McGraw-Hill Book Company of New York, and for sale by Technical Book Shop, Rialto Bldg., San Francisco Price, 4.00

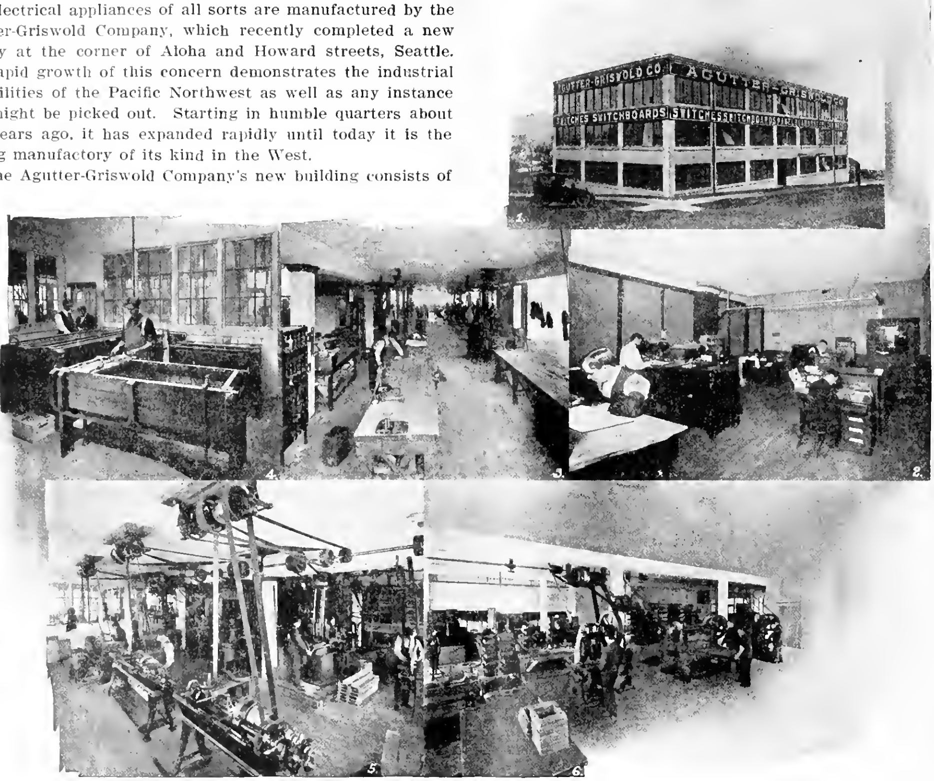
The author's long experience in engineering testing both in the technical colleges and in the great industrial companies has made him peculiarly adapted for the production of a manual of testing suitable for the needs of the students and yet applicable also for the engineer in the practice of his profession. The book discusses all the latest methods for testing engines, turbines, boilers, pumps, refrigerating machinery, fans, fuels, and materials of construction. The book is an excellent college text-book and being so recent is indispensable to the testing engineer.

INDUSTRIAL

AGUTTER-GRISWOLD COMPANY'S NEW FACTORY.

Electrical appliances of all sorts are manufactured by the Agutter-Griswold Company, which recently completed a new factory at the corner of Aloha and Howard streets, Seattle. The rapid growth of this concern demonstrates the industrial possibilities of the Pacific Northwest as well as any instance that might be picked out. Starting in humble quarters about four years ago, it has expanded rapidly until today it is the leading manufactory of its kind in the West.

The Agutter-Griswold Company's new building consists of three stories and a basement. It is a concrete structure, 60x120 feet, with 21,000 square feet of floor space. The first floor is used for office and storeroom purposes. The heavy machinery required for punching and forming switch and panel parts is housed on the second floor, where some of the assembling work is also done.



1. Factory at Aloha and Howard. 2. Section of General Offices. 3. View of Assembly Floor. 4. Plating Department. 5. View of Machine Shop. 6. Steel Box Department.

Other machinery required in the construction of steel cabinets is located on the third floor. It also accommodates the plating, lacquering and polishing department. The building is equipped with fireproof vaults for the storage of documents, dies and expensive tools used in the various manufacturing processes. All the machinery is electrically driven.

ILLUSTRATIVE REPORT FROM WALL STREET JOURNAL

In comparison with most industrials the business of the Western Electric Company is holding up remarkably well. Although four out of the last five months have shown a decrease in gross business, the falling off has been so slight that the increase in the first three months is sufficient to make the whole eight months that have elapsed, show a gain of 3 per cent over the corresponding eight months of 1910.

August was off about 3 per cent as compared with August, 1910, July was also off 3 per cent from last year, June off 4 per cent, May showed a slight gain and April a falling off of about 4 per cent in comparison with April. Business so far has run at the rate of about $66,000,000 for the year, and as there are only four months left it seems more than likely that 1911 will rank as the company's second largest year, even taking into consideration further decreases, which may or may not materialize. On the basis of gross sales of $66,000,000 this year would compare with previous years as follows:

	Gross Sales.	Increase.	P. C.
1911	*$66,000,000	$ 5,000,000	8
1910	61,000,000	15,000,000	32
1909	46,000,000	13,000,000	40
1908	32,000,000	†21,000,000	†39
1907	53,000,000	†16,000,000	†23
1906	69,000,000	25,000,000	56
1905	44,000,000	12,000,000	37
1904	32,000,000	2,000,000	6
1903	30,000,000	1,000,000	3
1902	29,000,000	5,000,000	20
1901	24,000,000	—	—
1900	24,000,000	—	—
Total	$510,000,060		

*Estimated.
†Decrease.

The falling off in business has come chiefly from the eastern section of the country, the south, the middle and far western territories showing improvement as compared with last year.

NEWS NOTES

FINANCIAL.

ALBANY, ORE.—The Mayor will appoint a committee to investigate the feasibility of a $500,000 water system.

LEAVENWORTH, WASH.—A $50,000 bond issue is to be submitted to the voters of Leavenworth at an early date. The funds are to pay for the municipal water plant.

GRESHAM, ORE.—The Gresham water system bonds issue of $20,000 has been decided in favor of the issue and work on the water system is to begin as soon as possible.

SACRAMENTO, CAL.—Ten of the first consolidated mortgage 5 per cent bonds of the Sacramento Electric, Gas & Railway Company will be retired in accordance with the provisions of the sinking fund. Bids for the sale of this or a similar number of bonds will be received by the Mercantile Trust Company of San Francisco, as trustee, prior to noon of October 30, 1911.

ILLUMINATION.

ABERDEEN, WASH.—The City Council is considering the advisability of installing a municipal lighting plant.

TRACY, CAL.—An application for a franchise to establish a gas plant in this city, has been presented by H. F. Tillotson, of San Francisco.

SNOHOMISH, WASH.—The local council is conferring with the Everett Gas Company in regard to the betterment of the local lighting system.

THE DALLES, ORE.—The Hydroelectric Company of Hood River is asking a fifty-year franchise of this place for supplying the city with light.

SEATTLE, WASH.—The City of Seattle will erect an $8631 power plant at 1179 Eastlake avenue. B. H. Graff, 601 American Bank Building, contractor.

ASHLAND, ORE.—It is probable that officials of the Siskiyou Power & Light Company will submit a proposal to this municipality for the purchase of the municipal power plant.

THE DALLES, ORE.—N. C. Evans of Hood River asked for the right and franchise to erect and maintain poles and wires, and supply The Dalles with electricity for power and lights.

WHITTIER, CAL.—C. S. S. Forney, president of the Southern Counties Gas Company, has appeared before the City Council and asked that a gas franchise be advertised for sale.

WOOLLEY, WASH.—A franchise for the Bellingham and Skagit County Interurban Railway Company, to operate an electric lighting and power station in this city has been applied for.

MEDFORD, ORE.—The Southern Oregon Electric Company has received the contract for a street cluster lighting system at a bid of $37 per post and 28 cents per running foot for wiring.

TACOMA, WASH.—Griffin Wheel Company has awarded a contract to Evans-Dickson Company, electrical engineers, for the installation of a complete lighting system in their plant. The work will cost $1500.

LOS ANGELES, CAL.—The Board of Supervisors has awarded the contract for placing an electric generating plant in the Hall of Records to the C. C. Moore Engine Company at their bid of $21,000.

VANCOUVER, WASH.—It is reported that the Skamania Light & Power Company, S. Sampson of Stevenson, Wash., president, will apply for a franchise to enter the city with a power and electric light line.

WALLACE, IDAHO.—The Washington Power Company will at once extend its lines into Sunset County for the purpose of furnishing power for the Manhattan and Amazon mines. The company's engineers are on the ground instituting work.

FULLERTON, CAL.—The city has entered into a three years contract with the Southern California Edison Company for an improved lighting system. The plans being to use about seventy-five large tungstens and the adoption of a center suspension.

SEATTLE, WASH.—The county commissioners will on October 24th consider the application of Roy W. Comegys for a franchise for rights of way over certain county roads and streets for the construction of electric light lines and electric light systems.

ANACORTES, WASH.—Julius Nelson, J. P. Benton and E. D. Nelson have petitioned the municipal council for a 30-year franchise for a gas service. They propose the immediate erection of a gas plant and mains and laterals for high-grade lighting and heating purposes.

SAN FRANCISCO, CAL.—Word has been received from the authorities in Washington awarding the contract for the construction of the electrical system at Fort Miley to the McFell Electrical Company, on their bid of $17,210. The work includes the complete installation of an electric light system.

PASADENA, CAL.—The City Council has awarded a contract for the work on Orange Grove avenue, between Colorado street and Columbia street, and on Colorado, California and Columbia streets to W. A. McNally & Co., at $30,-400, for installing lighting posts, underground cables and wires.

INCORPORATIONS.

IRONDALE, CAL.—The Irondale Electric & Power Company has been incorporated for $50,000, by F. M. Brown, J. D. Phillips and others.

PHOENIX, ARIZ.—The Thousand Springs Power Company has been incorporated for $2,000,000, by F. N. Bancroft, vice-president, and J. J. Crippen, secretary. The home office is in Denver, Colo.

LEBANON, ORE.—The Sweet Home Water Company has been incorporated by R. C. Watkins, W. M. Malone, A. Schippl and J. H. Goings. The company expects to begin work at once on the building of a reservoir on the hill near the school house a half mile east of the town.

MARTINEZ, CAL.—Acting for some new water company which is planning to enter Contra Costa and Alameda counties in opposition to the People's Water Company and the Union Water Company, Charles Bacon of a local abstract firm Saturday filed two water appropriations for 60,000 inches of water to be taken from the San Joaquin River. Bacon refused absolutely to be questioned in any way, and would not even state who he was acting for. He did admit to one of the clerks in the county clerk's office, however, that the new water company was planning to supply Oakland, Brentwood, Walnut Creek, Concord, Byron and Livermore.

TRANSMISSION.

GRIDLEY, CAL.—The Gridley Produce & Canning Company's creamery and ice plant is preparing to install its own power and lighting plant.

WALLACE, IDAHO.—The Washington Water Power Company will at once extend its line to the Sunset country, primarily to furnish power for the Manhattan and Amazon mines.

REDDING, CAL.—Peace has settled down again upon the lines of the two power companies that have been at war in Shasta County. A stipulation provides that the Sacra-

mento Valley Company, which is building its system, shall correct three of the crossings where it passes over the lines of the Northern California Company. The Sacramento Valley Company agrees to construct all crossings in the manner that shall be decided best by the two engineers.

BLAINE, WASH.—The construction of the transmission line of the British Columbia Electric Company from Cloverdale, B. C., to this place only awaits the ratification of the contract by the city council.

VENICE, CAL.—The Abbot Kinney Company will build a power house here to compete with the Southern California Edison Company. Orders for machinery have been placed and an investment of $100,000 is planned.

SAN BERNARDINO, CAL.—City Engineer Poole and other officials of the Southern Sierra Power Company will be here soon and finally pass on the surveys of the high power line and also the plans for the power house to be erected between San Bernardino and Colton.

MARTINEZ, CAL.—Maps and permits showing the route to be taken along the waterfront by the Great Western Power Company in its invasion of the territory formerly held exclusively by the Pacific Gas & Electric Company, were filed with the county clerk yesterday. The entrance of this company into the field here is creating a great deal of interest among the officials of the large manufacturing plants, as it is stated they are offering power and heat at about one-half that charged by the latter company. Franchises along the waterfront from Crockett to Martinez grant the company right over many miles and the privilege of opening a plant at Martinez.

TRANSPORTATION.

KAMLOOPS, B. C.—This place is considering the advisability of spending $223,000 for securing hydroelectric power from the Barrier river.

BURLINGTON, WASH.—The City Council has granted a franchise to the Bellingham-Skagit interurban to pass through the city from north to south.

HUSUM, WASH.—The Pacific Power & Light Company has applied for a permit to construct an electric line from the plant at this point to Underwood.

EUGENE, ORE.—The Oregon Electric Railway Company has surveyors at work near here establishing levels preparatory to active construction work in the near future.

SEATTLE, WASH.—City Engineer R. H. Thomson has been instructed to prepare plans for the construction of the Seattle-Renton electric railway system of this city. Estimated cost, $800,000.

VICTORIA, B. C.—It is announced that the British Columbia Electric Railroad Company will proceed at once with the construction of 18 miles of suburban extension of that road along the Saanich peninsula.

WHITEFISH, MONT.—It is announced that D. R. McGinnis, Flathead capitalist, is making arrangements to finance the proposed Kalispell-Whitefish electric road, and it is thought that work will start this fall.

VANCOUVER, WASH.—It is reported that the Mount Hood Railway & Power Company will expend more than $1,000,000 in building electric lines in Vancouver and Clark county within the next two years.

MOSCOW, IDAHO.—It is announced that the Spokane & Inland Empire railroad will erect stations on the Moscow and Colfax lines. Plans are now being prepared at the office of R. Budd, chief engineer, in Spokane.

SANTA ANA, CAL.—The City Council has passed an ordinance relating to the franchise of the Santa Ana and Westminister Railway Company on Second street, so that electricity may be used as motive power on Second street.

SANTA MONICA, CAL.—The City Council has passed an ordinance granting to the Los Angeles Pacific Company the right to construct and for a period of fifty years operate a single or double track electric railroad upon certain public streets of this city.

CHELAN, WASH.—H. M. Herzog of Seatte, at the head of a company of engineers, has started surveying the Chelan river gorge. It is reported that this work is being done for the location of the dam contemplated by the Great Northern for the development of power.

SEATTLE WASH.—The City Council has passed a resolution, instructing the board of public works to call for bids for the construction of a municipal car line where the old Renton line is now located. The next step will have to be taken by the Board of Public Works.

BAKER, ORE.—F. A. Harmon and E. P. Bodinson, local delegates of the Commercial Club on the feasibility of constructing an interurban railway from this city to some outside point, have returned from Boise, Idaho. The delegates were enthusiastic in regard to the proposed line.

VANCOUVER, B. C.—A plan is on foot for the construction of an electric line and supplying electric power to private consumers throughout the Okanagan valley. This is to be done under a charter granted to the Coteau Power Company and recently acquired by Wm. Mackenzie, Donald Mann and their associates.

BAKERSFIELD, CAL.—Application has been made to the Board of Trustees by the San Joaquin Light & Power Company for a franchise, for a period of 50 years, to construct and maintain a street railroad upon certain public streets and highways, to be operated by electricity in the city of Bakersfield.

MISSOULA, MONT.—Charles A. Clark, representing his father, W. A. Clark, announces that he has ordered the local officials of the Clark Street Railway Company to start surveying immediately for an electric railway from Missoula across the southwestern portion of the Flathead country to the foot of the Flathead lake.

VANCOUVER, WASH.—The City Council has practically agreed to grant an electric railway franchise to Lawrence Harmon, said to represent Chicago capitalists. The company represented binds itself to have at least three miles of road in operation by April, 1914, and is also expected to build into various parts of Clark county.

SEATTLE, WASH.—It is announced that Dibble-Hawthorne & Co., Bank of Commerce Building, Tacoma, have secured the contract for constructing the electric line from Oxbow to Lake Burien for the Highland Park & Lake Burien Railway Company, American Bank Building, Seattle, at approximately $150,000, to be seven miles in extent.

LOS ANGELES, CAL.—Plans for a five-mile track to be the connecting link of the Corona and Colton systems, and giving a clear run from Corona to Riverside and San Bernardino were made by the Pacific Electric officials recently. Work on the track will be started at once, P. D. Wing being commissioned by the company to procure the proper franchise.

MARTINEZ, CAL.—The positive assurance has been given that if the people of Martinez, Alhambra Valley and the surrounding country will subscribe to stock and buy bonds in the sum of $150,000, an electric line will be built from the county seat through the Alhambra Valley to Walnut Creek, connecting there with the main line of the Oakland & Antioch Railway.

SAN FRANCISCO, CAL.—The United Properties Company has given out a contract for $2,000,000 worth of electrical equipment. Just what this order consists of cannot be learned, but it is believed that this is the first move toward important extensions of the Key Route system. According to President E. A. Heron, work on the system north to Richmond and San Pablo and south to San Jose will be rushed within the next few months.

PORTLAND, ORE.—Chicago capitalists have organized a company to construct an electric line from Vancouver, Wash., north to the South Fork of the Lewis River, north-

east to Klickitat Pass, a distance of 100 miles. In addition to the electric line, the promoters will operate coal mines, sawmills and townsite properties. Between $10,000,000 and $15,000,000 is back of the project. H. L. Harmon of Chicago is promoting the enterprise. In his absence E. R. Ernsberger, of the Mt. Hood Railway & Power Company, looks after the interests of the concern.

SAN FRANCISCO, CAL.—It is announced that the laying of steel for the Tidewater & Southern railroad will begin at Turlock within a week. J. H. Wallace, chief engineer of the company, has completed arrangements with the Southern Pacific Company for the construction of a spur track within the city limits of Turlock to connect the Southern Pacific's main line with the right of way of the Tidewater Southern, thereby permitting the transfer of cars loaded with ties, steel and equipment from one system to the other. Grading of the right of way from a considerable distance north has been completed to the limits of Turlock, but the Tidewater and Southern management decided to refrain from tearing up city streets until absolutely necessary.

SAN FRANCISCO, CAL.—A loop for the western end of the Geary street city railroad has been recommended to the Mayor and Supervisors by Patrick Broderick, the superintendent of construction of this railway, and Public Works Commissioner Cuarles S. Lanmeister. The loop plan provides for the following rcute: From Thirty-third avenue along Pt. Lobos avenue to Forty-eighth avenue, thence along Cliff avenue and the Great Highway to C street, along C street to Thirty-seventh avenue, and then on Thirty-seventh avenue, B street, Thirty-sixth avenue, A street and Thirty-third avenue to Point Lobos avenue. It is stated by Broderick and Laumeister that this scheme will keep the city railway from crossing the United Railroads tracks and the use of the United Railroads tracks will be wholly avoided.

TELEPHONE AND TELEGRAPH.

FRESNO, CAL.—A complete telephone system is to be established along the route of the Guaranty Pipe Line Company from the Midway oil field to Ventura and bids are now being received pending the letting or the contract.

FORT SHAW, MONT.—J. B. Bond, engineer of the Sun River Irrigation project, is in the canyon and Willow Creek, located near this city, arranging for the immediate construction of a telephone line between Willow Creek and Warm Springs.

HANSEN, IDAHO.—A movement is well along by independent and disconnected rural telephone systems in Twin Falls county for the connection of all the rural lines. The territory served will be widened by the additional construction of lines.

SEATTLE, WASH.—The U. S. transport Burnside has departed for Alaska waters to start repair work on the government cable between Sitka and Valdez.

VALE, ORE.—The city has decided to permit the Independent telephone line to come into the city.

BAKERSFIELD, CAL.—Bids are about to be sought from Bakersfield building contractors for construction of the three-story and basement building of the Pacific Telephone & Telegraph Company on the north side of Twentieth street. The building, equipped as a central office and exchange, will cost $80,000. Although the general plans were made in the architectural office of the company at San Francisco, Orville L. Clark of this city will be supervising architect. The building will be made of reinforced concrete with facade of mission design, executed in cement with brick and granite trimmings.

COLUSA, CAL.—The committee of telephone patrons appointed to meet with the directors of the Colusa County Telephone Company Saturday afternoon received little encouragement, the officials remaining firm in their decision to raise the telephone rates, beginning October 1. They made no impression on the officials of the telephone company, which has no competition in this county. They were informed to present the notice, which is signed by 110 subscribers to the main office and the instruments of the protesting parties would be removed. The committee was also informed that to again obtain a telephone after the instrument is once removed would cost $5 besides the regular rate. The directors of the telephone company are J. F. Campbell, Oscar Robinson, J. H. Balsdon, Charles Schaad and Dr. W. T. Rathbun.

LOS ANGELES, CAL.—Reports are current here that the Home Telephone Company is planning to sell its plants and equipment in California to the Pacific Telephone & Telegraph Company. It is stated that the deal will include the Home Company of Los Angeles, the Bay Cities, which embraces those at San Francisco, Oakland and Berkeley, and the subsidiary concerns in the State. It is no secret that the Home Company has found it an uphill fight against the Pacific, especially in San Francisco and the other cities about the bay. For a time its business here gave promise of great proportions, but of late the Pacific has strengthened itself through the purchase of a number of small companies in Southern California. It is thought that the deal may take the form of a consolidation or merger, through which the holders of Home Telephone securities would be given honds or stock of the Pacific Company. Officials of the two companies state that the matter has not reached a stage where it can be discussed.

WATERWORKS.

HERMISTON, ORE.—Hermiston will advertise for bids for the sale of bonds for the construction of the Hermiston water system.

VISALIA, CAL.—Exeter has voted for a new water system, carrying the $42,500 bonds by a vote of 120 to 8. The success of the bond issue means the extension of the water system and fire protection all over the municipality.

JACKSONVILLE, CAL.—A contract for the completion of the Jacksonville waterworks system, began last year by J. I. Mears, has been awarded to the Jacobson-Bade Company for the sum of $43,000 less the amount of estimate allowed Mears for the completed work and material.

HONOLULU, T. H.—Bringing water from the windward side of the island at a cost of $1,500,000 is the plan of the two engineers, J. B. Lippincott and Carl Worthen, who have been studying the proposition for the Oahu Sugar Company. Roughly, the plan is to bring the water by a tunnel at the head of Walahole gulch through to the head of Waihawa gulch and from there distribute the water where needed. The system will have a capacity of 100,000,000 gallons daily, and a daily minimum flow of 15,000,000.

BAKERSFIELD, CAL.—The Western Water Company, a Bakersfield corporation, plans to supply Taft and the Midway field with a fresh water supply taken from wells sunk near the river, and has completed its station No. 1 at the water wells and is awaiting the pumping machinery. Four miles of the pipe line ditch, have been completed and a ditching machine is now to be used to complete this work, and it is expected to make progress at the rate of close to a mile a day. The company expects to be delivering water to its customers by October 1, when a supply of 20,000 barrels will be available. Contracts are now being made with the oil companies of the Midway territory, the Union Oil Company having contracted for 10,000 barrels a day for five years. Station No. 2, in the town of Taft, is now being made ready. The plant is in triangular tract at the head of Kern street, extending from North to Lucard street, with 250 feet frontage on Lucard and 640 between North and Lucard. The main office will be opposite Kern street. It will be a frame building. The power house will be on Lucard street, with the supply warehouse in the rear.

APLHABETICAL INDEX TO ADVERTISERS

// JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

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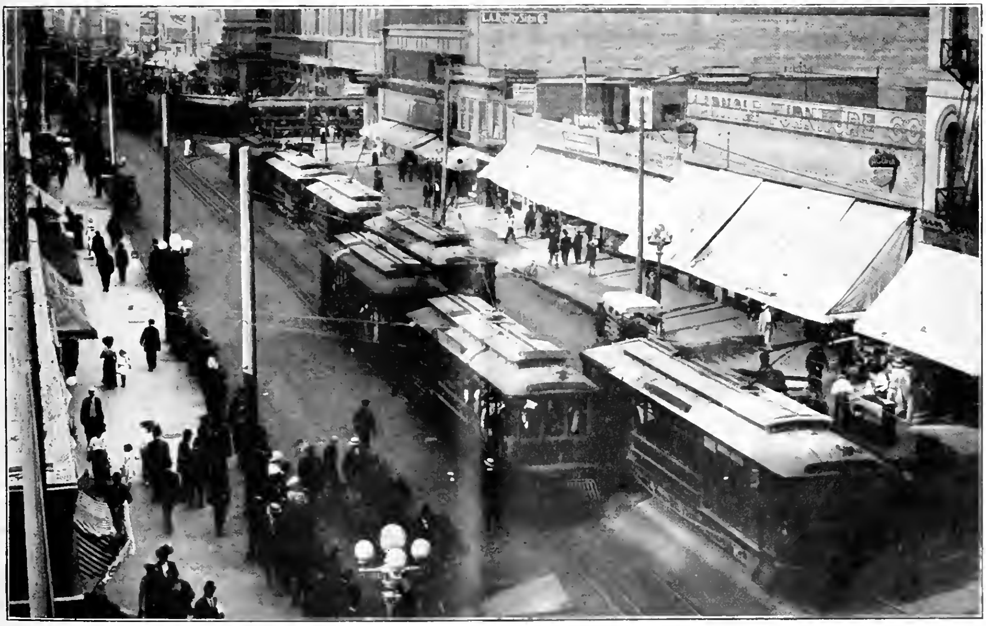
TRAFFIC CONGESTION IN LOS ANGELES.

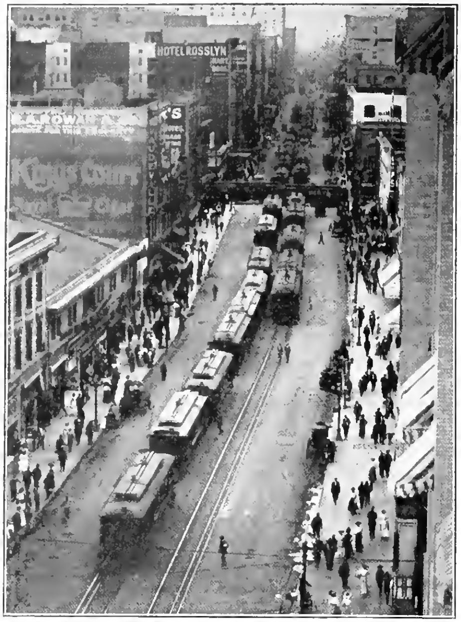
The congestion of an enormous population into relatively small areas in the rapidly growing American cities has given rise to a new branch of modern engineering. In the cities of New York, Chicago, and Philadelphia, agitation over resultant traffic demoralization, led these cities to institute investigations of ways and means for betterment several years ago. Commissions were appointed, engineers retained and systematic study undertaken. The result has been that out of chaos and confusion well-regulated traffic balance is being maintained throughout the great cities of the East.



Los Angeles Car Congestion on Main Street. It is hoped to remedy this evil in the Southern California city by routing the Suburban Cars on San Pedro.

The unprecedented growth of the cities of the West has created conditions new and unencountered in the slow and steady growth of eastern cities. All of the larger coast cities are today suffering from want of proper and systematic planning in the handling of the enormous suburban crowds flooding the business districts during certain hours of the day. The first city to actually employ an expert versed in traffic congestion experiences is Los Angeles. San Francisco has recently followed her example and it is to be hoped that immediate and effective recommendations will be made and acted upon to take care of the paralyzed condition there met with due to the recent influx of people anticipating early activities to be brought into life in the working out of the details of the Panama-Pacific Fair.

In the study of conditions at Los Angeles and in fact in the case of San Francisco, Bion J. Arnold,

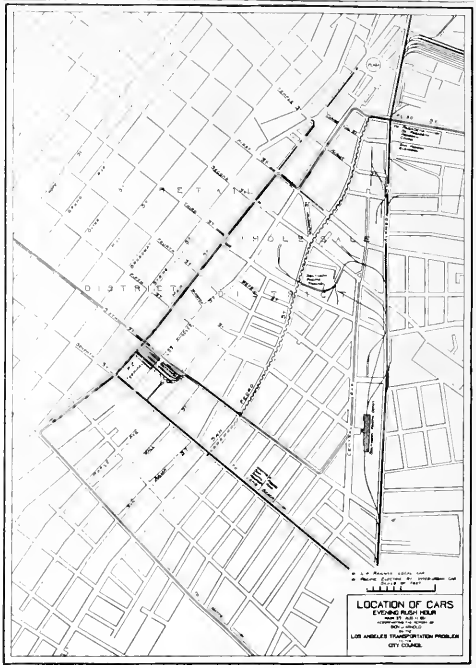


One mile of Car Congestion in Los Angeles on Main Street.

the well known traffic expert of Chicago, is retained. A partial report for betterment of conditions at Los Angeles has just been made and interesting recommendations are now being acted upon.

Bion J. Arnold, the Noted Traffic Expert, Who is conducting an Investiation in Los Angeles and San Francisco.

Bion J. Arnold has submitted his report on the traffic congestion in Los Angeles and the same has been approved by the Municipal Railroad Committee



Map of Congested Portion of Los Angeles.

and will be acted upon soon by the City Council. Mr. Arnold's report is very interesting and points out indirectly the immense growth of Los Angeles during recent years.

It is proposed to take the interurban cars from Main street to San Pedro. Two plans are proposed for the building of the line on San Pedro, one plan is for the city, at a cost which Mr. Arnold estimates to be about $130,000, to build the railroad itself. The other is for the city to have the traffic companies build the railroad with the stipulation that the City of Los Angeles be allowed in time to take the road over. Mayor Alexander has sent a message to the City Council suggesting these two methods as to how the railroad should be financed.

In his report Mr. Arnold discusses the congestion on Main street at length. He states that fully 5000 riders on both systems are delayed from five to forty minutes during the rush hours each day and as many more are inconvenienced during the rush hours due to the fundamental defects of the transportation arrangements in Main street.

He also speaks of the inconvenient arrangement for getting in and out of the Pacific Electric depot at Sixth street and of the clashes that occur. Inside the station the arrangements are imperfect..

The following is an abstract of Mr. Arnold's interesting report:

All interurban cars using this terminal must wait their turn to discharge and load passengers, and no provision has been made, by means of storage tracks, to supply trippers or extras to take the place of

delayed cars. The loading arrangements are not designed to handle crowds conveniently or comfortably. In order to take a car one must stand before a closed gate until his car is called and as the schedule becomes disarranged during the blockade there is no way of telling when any particular car is to be expected. Frequently the delays to the standing patrons becomes exceedingly tedious, and when the car does come there is a general scramble and contest to obtain a seat. The height of the car steps above the ground-level platform makes loading slow and inconvenient, especially to passengers with hand baggage.

The cars leave the terminal slowly, as they must find their place in the procession of local cars and at every street intersection the entire line of mixed traffic is further delayed, either by crossing cars and vehicles, or by surface cars weaving their way in or out of the file. At one place (Third and Main streets), the intersecting line becomes part of the main line for a short distance, causing a double delay, which is made worse by the overhang of the cars and the spacing of the track centers on the curves which permits only one car to pass at a time. The fact that the cars from different systems and routes are alternated prevents the moving of the cars across the intersections in lots of two and three at a time, and as it is hard to tell whether a car is going straight ahead or is to turn a corner, both the vehicle traffic and the pedestrian travel are considerably delayed at nearly every street crossing.

As a rule the schedule provides for a liberal number of seats, but the Main street difficulties introduce delays which reduce the car supply just at a time when the system should be working at its maximum capacity.

There are apparently two financial and franchise plans by means of which the proposed tracks on San Pedro street could be built.

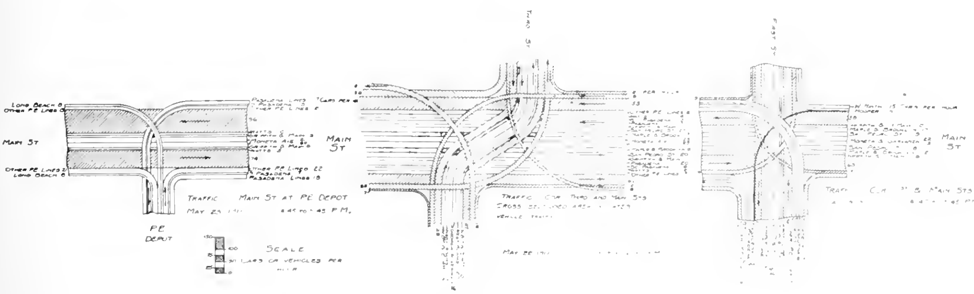
One plan, which might be called the immediate municipal ownership plan, would be for the city to construct the tracks with its own funds as part of the proposed municipal railroad and enter into an arrangement with the Pacific Electric company for the use of these tracks on a rental basis.

The other plan, which may be termed the ultimate municipal ownership plan, would be for the Pacific Electric Company to build tracks under an agreement that the city is to have the right to purchase the tracks at any time at actual cost, and that as soon as a permanent right of way can be provided by means of an elevated or sub-surface structure, the company will withdraw its interurban cars from the street surface. This latter plan would practically be an indeterminate franchise, which is sometimes called a tenure during good behavior, and is a form of permit for public utilities which is rapidly growing in favor, as it combines the advantages of both the short term franchise and the long term franchise without their objectionable features.

It is not the intention of this preliminary technical report to discuss at length the comparative merits of these two plans. With proper precautions either form of agreement will accomplish the result desired, and that is to relieve the Main street congestion by allowing the use of San Pedro street for the interurban cars as a temporary expedient pending the development of a permanent and independent terminal for the Pacific Electric system. As any agreement would not be a permanent one, it would seem that the result to be accomplished is of greater importance than the method selected to secure the improvement.

WORLD EXPOSITION PLANS IN JAPAN:

The authorities of the city of Tokyo have decided to give a grant of $3,500,000 gold to the International Exhibition which will be held there in 1917. Of this sum $1,500,000 will be devoted to the acquisition of land for the site, $1,250,000 for constructing gardens, and the remaining $750,000 to provide an adequate tram, train, and cab service, to make provision for sanitary arrangements, to cover the preliminary expenses for plans, guides, etc., to arrange a thoroughly efficient fire service, and to construct the section containing the city exhibits.



DIAGRAMS SHOWING MOVEMENT OF TRAFFIC ON MAIN STREET, LOS ANGELES.
Width of Band Represents Number of Cars and Vehicles per Rush Hour.

40 per cent of the cars on the local system, and 60 per cent of the interurban cars are affected by the Main-street Congestion.

There are three principal points of congestion along Main Street. At the Pacific Electrical Terminal—at Sixth and Main Streets the interurban cars enter and leave their "stub end" terminal by means of double track intersecting curves.

At Third and Main Streets, the Third-Street tracks not only intersect the Main-Street tracks, but parallel them for a short distance, and the curves here allow only one Third Street car to cross at one time.

At First and Main there are two sets of curves; one to allow the interurban cars to leave Main Street, and the other between the North Main Street and the West First Street tracks.

ADVERTISING GAS AND ELECTRIC SERVICE.[1]

BY WILLIAM H. HODGE.[2]

Advertising gas and electric service in newspaper space does not differ in essentials from advertising any other retail business. Success lies in studying the market, presenting the attractive points of what is offered for sale and doing these things in a systematical, careful way.

Utility organizations in cities of more than 75,000 people are large enough to hire individual advertising ability. If they do not do so they are shortsighted. .

Successful advertising on a large scale must be handled by men who have spent years learning how. They should be employed by the advertiser, receive their entire compensation from him and accept no commissions from publishers. They cannot impart their experience, knowledge and skill to others no matter how willing they are to instruct any more than a successful lawyer can tell other lawyers how to win cases, or a good merchant can transmit to his neighbor the secret of running a paying department store. Advertising for central stations, gas companies, shoe stores, breakfast foods, real estate or any other service or commodity can be productive or expensive. It all depends upon how it is done.

The smaller central stations and gas companies often find it impractical to employ special advertising assistance. The smaller organizations need the service which efficient advertising can render even more than the large organizations, for the smaller the city the greater is the proportion of possible business which the company requires in order to pay interest and dividends.

Leaders in utility operation pointed out some years ago that there must be a limit to development producing lower costs of manufacture and distribution, and that the volume of sales must be increased, and a close margin be maintained between costs and selling prices, if the gas and electric industries were to justify their commercial existence. Most utility organizations have realized the force of these conditions and have greatly improved their sales methods. They have abandoned the idea of a spontaneous demand and have acknowledged that the creation of a satisfactory market lies in salesmanship and advertising.

Results have fully warranted these conclusions. Companies which cannot afford to employ exclusive advertising assistance, or to whom advertising skill is not readily available, have open several ways out of the difficulty. Three are as follows:

1. By syndicating their demands.
2. By purchasing at a low price the ready made advertising copy offered by several excellent sources.
3. By endeavoring to train someone in the new business force to do the work in conjunction with the material offered by manufacturers.

Syndicating the publicity requirements of a number of stations enables the employment of copy service for each by prorating the cost. It is in line with modern utility operation.

[1]Written specially for the Journal of Electricity, Power and Gas.

[2]Publicity Manager for the H. M. Byllesby Companies.

Criticism of so-called "canned copy"—that is, ready made ads—has no particular weight. An electrict flat iron is an electric flat iron the world over, and people use it for the same purposes and are attracted by the same features. Gas ranges are used for cooking in New York, San Francisco, Mexico City and Montreal. National advertising campaigns for all kinds of commodities cover the country with identical and simultaneous copy. "Canned copy" has nothing inherent to make it defective. If the matter and ideas are good, they are good any place. If they are bad they are not worth while using. Neither is any other advertising literature.

The third plan suggested is not as reliable as the others, but has interesting potentialities. Manufacturers supply creditable electrotypes and copy, and suppress the individuality of their own goods for the interests of utility companies. Few managers have the slightest idea of what this service costs the manufacturers. It is higher than generally supposed. Use of the service often entails mutual obligations which the company, on its part, does not care to assume.

An impression prevails among utility managers that they should buy and use local newspaper space as a matter of policy, if for no other reason. This is an unhealthy theory and is gradually being dropped. It does not help to make commercial advertising pay, although it is possible to do so, and is an attitude which is difficult to defend.

Whenever a utility company has a public controversy on hand it can make no better or wiser move than to present its side of the case in the daily newspapers. Advertising space at current rates should be bought. The contents of the advertisement should be skillfully prepared.

No municipal ownership agitation intelligently met in this way has resulted in the construction of a publicly owned and operated utility. My own experience with this latter kind of publicity has been broader than in commercial advertising lines, and has extended pretty well over the country, the Pacific Coast included. It must have solid, substantial backing in actual conditions or it cannot be of more than superficial aid to utility management. In other words, a company must have the goods and be willing to deliver. Otherwise publicity work as a panacea is an interesting delusion.

This view applies to commercial advertising as well as to defensive and protective publicity. The large advertising agencies—the real exponents and developers of advertising practice—have recently emphasized the necessity for proper merchandizing as a foundation for profitable advertising. They are telling manufacturers and merchants that they have to put up their goods attractively, keep their capital in motion and give the best of attention to the precise terms upon which they offer their wares to the public or the cleverest advertising will not much help them.

One of the best things advertising does is the self analysis which it exacts. The ad-writer is compelled to search for points of attractiveness; to assemble the facts which would make the purchaser want to buy. If he cannot find them, and the article has intrinsic merit, something is wrong with the sales scheme.

Often the ad-writer picks out the faults and suggests corrections.

Many utility companies, large and small, have made advertising profitable and satisfactory. Any utility can make advertising pay by giving the subject the attention which it deserves.

ELECTRICAL ACTIVITY IN INLAND EMPIRE.

Carl R. Gray, president of the Spokane & Inland Empire Electric Railway Company says in the fifth annual report, just issued, for the year ended June 30, 1911, that while the street railway system in Spokane shows an increase in revenue over the year before, there were decreases on the interurban lines in northern Idaho and eastern Washington. However, he takes an optimistic view of the situation and predicts increased earnings for the coming year.

The total revenues from transportation for the year were $1,669,638.07, a decrease of $93,976.34 from last year, while the operating expenses amounted to $1,194,578.34, an increase of $112,410.71 over 1910. The average expense per mile operated was $5,740.40, an increase of $512.54. The net operating revenue was $745,059.73, a decrease of $206,387.95 from 1910.

The freight revenues were $399,980.92, a decrease of $72,937.36 from last year, and the passenger revenues $620,882.67, a decrease of $134,725.15 from the report for 1910. The street railway system showed a revenue of $549,110.89, an increase of $62,992.23, while other revenues amounte dto $99,663.59, an increase of $60,693.94 over last year.

Property investment, $5,282,620.54; material and supplies, $308,345.50; cash, $25,858.38; due from roads, companies and individuals, $77,273.63; sinking fund; $18,751.45; sundry expense accounts, $5,002.05, making a total of $25,718,852.63, while the liabilities include: Capital stock, common, $10,000,000; preferred rights, $6,409,100; first mortgage bonds, $4,951,500; payroll, audited accounts, vouchers and accounts, $281,147.97; bills payable, $3,667,448.64; accrued bond interest and taxes not yet payable, $94,472.49; accrued interest in floating debt, $2,711.28; sinking fund reserve, $14,584.60; sundry expense account, $16,604.99; profit and loss, $281,282.66; total, $25,718,852.63.

President Gray shows in closing his report that the physical condition of the property is excellent, adding that the roadbed has been kept in first class condition, with good banks, tie renewals have been made when necessary and ballast has been applied to practically the entire mileage. It has been the policy of the company, in order to build up industries along its lines, to put in spurs and sidings whenever business promises.

"Your lines," he says, "are built through a rich and developed country. On the inland division the Palouse country is harvesting this year an unusually large crop and we anticipate increased earnings for the coming year's operation. There is no new construction work contemplated, nor will there be unusual improvements calling for any large investment of money."

EVAPORATIVE TESTS ON A WATER TUBE BOILER.[1]

BY R. F. CHEVALIER.

Test of January 5, 1911.

The fires were lit under the boiler on the evening of the 4th and light fires maintained through the night. At 8:00 a. m., January 5th, steam was taken from the boiler so that the fires might burn at their rated capacity. The test was started at 9:00 a. m. and continued until 5:00 p. m. During the test, the fires were attended to by a regular fireman, who adjusted the fires according to instructions. The draft regulation was attended to by the writer. The boiler tested had been in operation since November 30, 1910. Prior to the test, the water had been drained from the boiler and the internal surfaces inspected. In the lower and intermediate steaming elements, there was no deposit of scale. In the feed water element, a slight scale was found, the thickness of which was about 1/32 of an inch. Both drums had a soft, slushy mud for the full length of the bottom and about 6 inches deep. This mud was removed and the drums washed. None of the tubes were cleaned internally. The soot was thoroughly blown from the heating surface on January 4th.

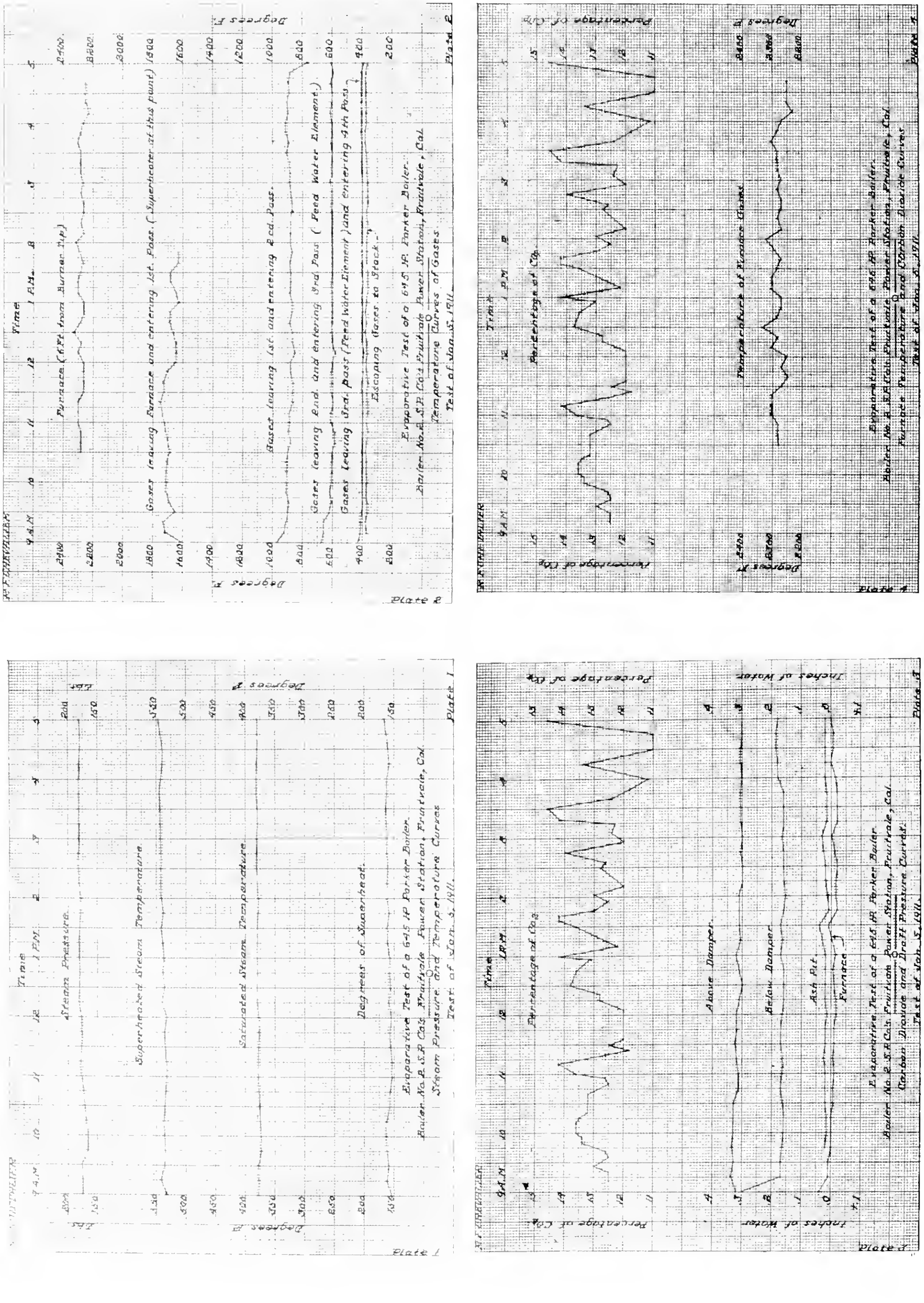
Test of March 18, 1911.

In the interval of time between January 5th and March 18th, the boiler had been operated intermittently at about one-half of the rating. Prior to the test, the boiler was opened and the tubes in the feed water element were scraped. The tubes in the intermediate and lower elements required no cleaning.

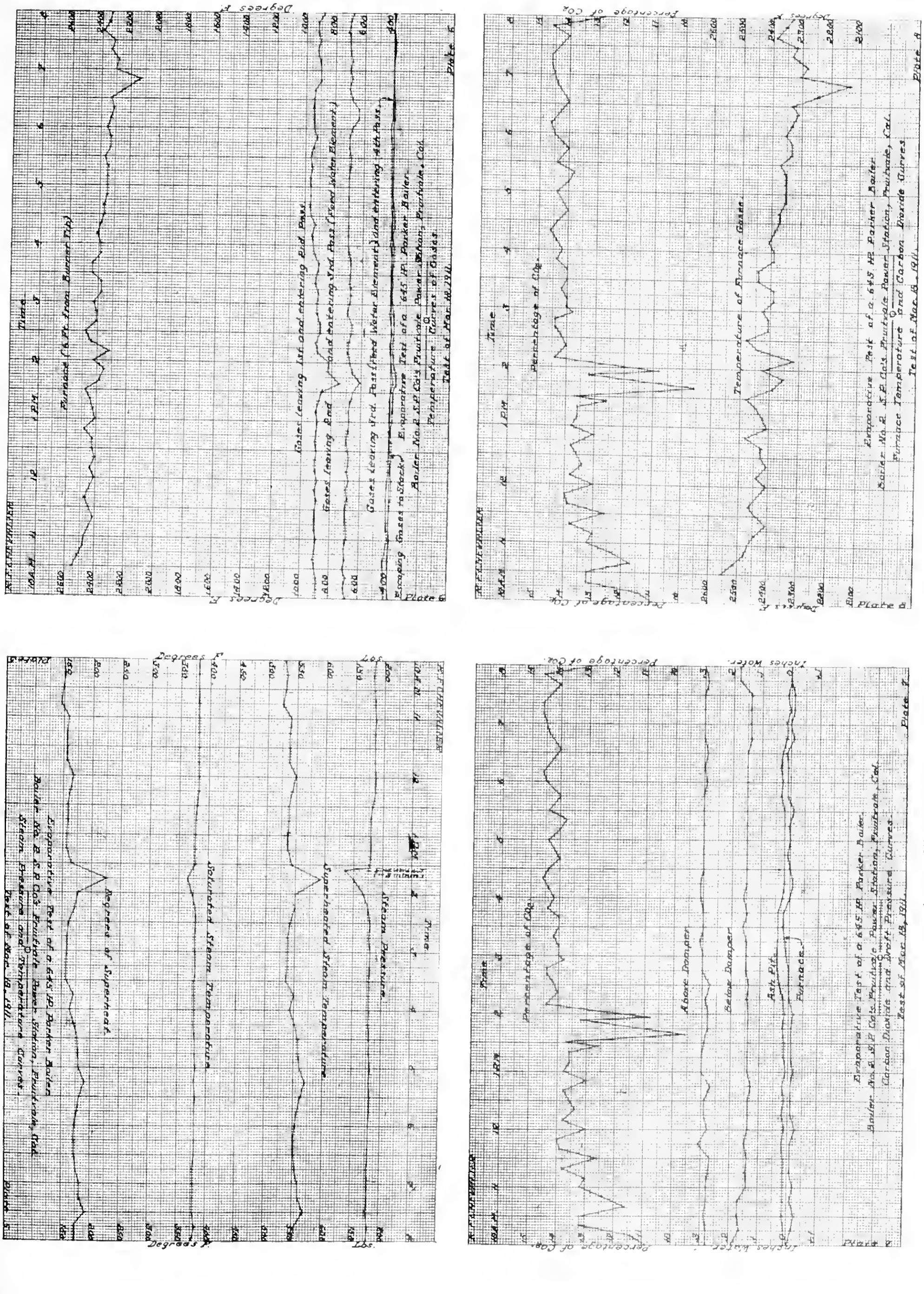
Fires were started under the boiler on the evening of March 16th and moderate fires maintained through the night. A test was made on March 17th, but owing to the irregularity of the load on the boiler, it was deemed advisable to make another test on the following day. Light fires were again kept under the boiler during the night. At 9:00 a. m. on March 18 steam was used from the boiler so that the fires could be burned at their rated capacity. The test was started at 10:00 a. m. and continued until 8:00 p. m. At 1:33 p. m. a strainer in the steam line to the oil pump, filled with scale from the steam pipe, necessitating a shut down of three minutes until the strainer could be taken out. The fires had to be extinguished but the flow of steam from the boiler was not interrupted, thus causing a drop in the pressure. The soot had been blown from the tubes on March 16th, and the boiler had thus been operated for about 30 hours before the time of the test without further removal of soot.

Although the heating surface of the superheater had been decreased, the degree of superheat was more in this test than in that of January 5th. This was due to the fact that the opening through the baffles between the furnace and the first pass had been shortened, causing a greater volume of the gases to sweep over the heating surface of the superheater. In all the tests conducted, no blisters nor signs of distress appeared on any of the tubes.

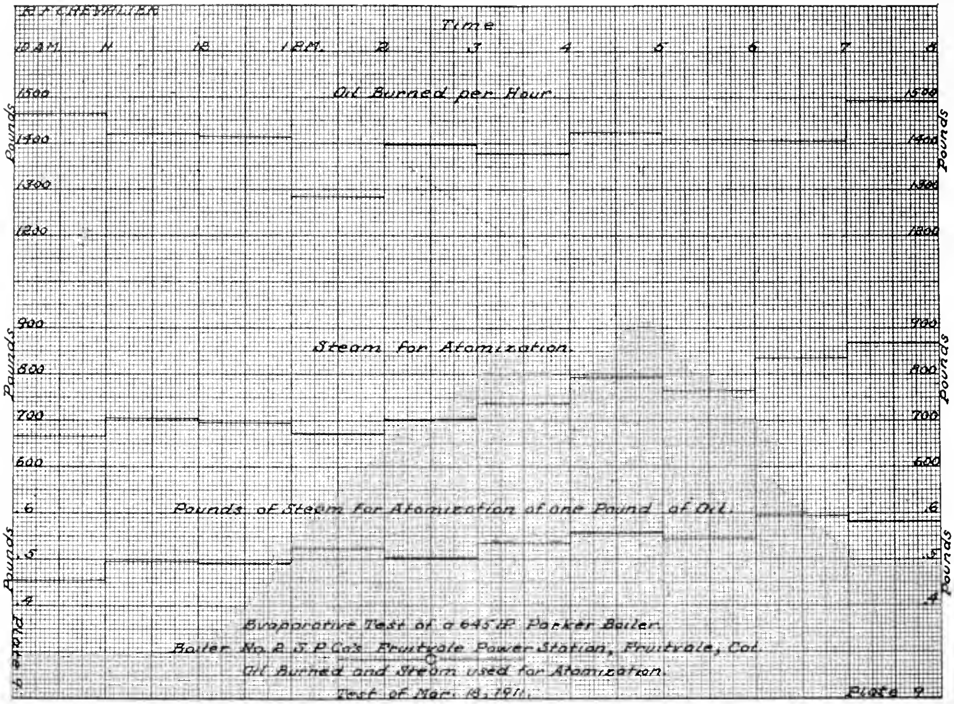
[1]Continued from issue of October 7, 1911.



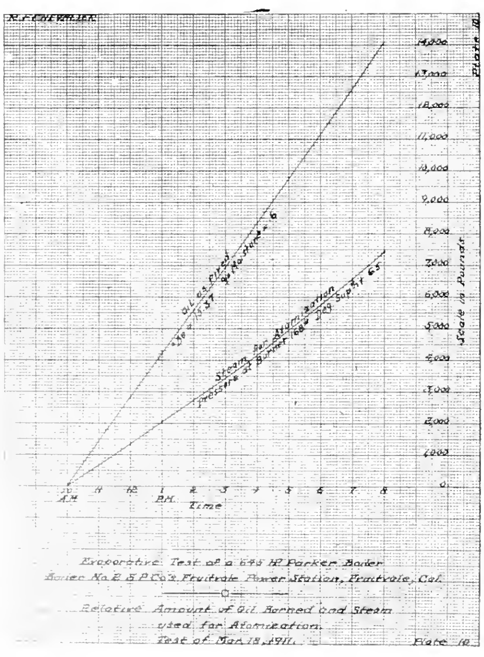
Curves Illustrating Test of 645 H.P. Parker Boiler on Jan. 5, 1911.



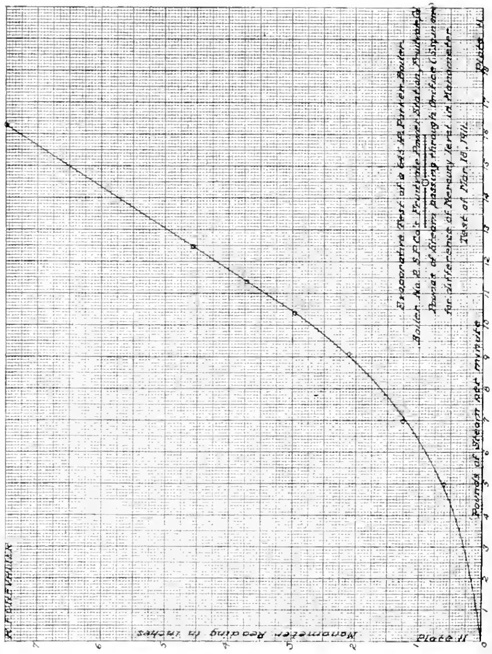
Curves Illustrating Test of 645 H.P. Parker Boiler on March 18, 1911



Curve Showing Oil Burned and Steam Used for Atomization.



Relationship of Steam Required for Atomization of Oil.



Calibration of Orifice Used in Measuring Steam for Atomization.

STEAM USED BY BURNERS FOR ATOMIZING THE FUEL OIL
Test of March 18th, 1911.

Pressure of steam at burner	168 lbs. per sq. in.
Temperature of steam at burner	440° F.
Degrees of superheat	65° F.
Total steam used by burners for ten hours	7,441 lb.
Total water fed to boiler for ten hours	189,240 lb.

$\frac{7,441}{180,240}$ = 4.16% of total water evaporated used by burners to atomize oil.

Equivalent evaporation from and at 212° F. for ten hours .... 224,218 lb.

$\frac{7,441}{224,218}$ = 3.32% of total equivalent evaporation used by burners.

Total weight of oil as fired for ten hours .... 14,093 lb

$\frac{7,441}{14,093}$ = .528 pounds of steam to atomize 1 lb. of oil.

RESULTS OF EVAPORATIVE TESTS ON A 645 H.P. PARKER BOILER AT THE S. P. CO.'S FRUITVALE POWER STATION, FRUITVALE, CAL.

1.	Date of test (1911)	Jan. 5th.	Mar. 18
2.	Duration of test (hours)	8	10
3.	Type of burner (Internal Mixer)		
4.	Make of burner (Owens)		
5.	Number of burners used	3	3
6.	Water-heating surface—sq. ft.	6080.	6080.
7.	Superheating surface—sq. ft.	134.4	107.5
	Average Pressures—		
8.	Barometer—inches	30.4	30.1
		lbs. sq. in.	
9.	Steam pressure by gauge (saturated)	178.5	179.7
10.	Oil pressure at burner	78.	92.
		ins. water	
11.	Force of draft in flue after damper	.31	.294
12.	Force of draft between damper and boiler	.165	.15
13.	Force of draft in furnace near superheat.	+.01	+.016
14.	Force of draft in ash pit	.02	.02
	Average Temperatures—		
15.	External air	degrees. F.	
16.	Fire room	75	78
17.	Air entering ash pit	75	81
18.	Furnace (6 ft. from burner tip)	2275	2390
19.	Gases entering 1st pass	1680	
20.	Gases leaving 1st pass and entering 2d	885	915
21.	Gases leaving 2d pass and entering 3d	610	690
22.	Gases leaving 3d pass and entering 4th	400	420
23.	Escaping gases from boiler	384	394
24.	Oil at burner	128	113
25.	Feed water entering boiler	165	123.4
26.	Superheated steam	539	561.2
27.	Saturated steam before superheated due to pressure	379	379.5
28.	Degrees of superheat	160	181.7
	Fuel—		
29.	Kind—California crude oil		
30.	Gravity of oil at 60° F.—specific	.9700	.9627
31.	Gravity of oil at 60° F.—deg. Be	14.43	15.37
32.	Percentage of water in the oil—%	1.2	0.6
33.	Calorific value of dry oil per lb—B.t.u.	18513	18681
34.	Weight of oil as fired—lbs.	11841	14093
35.	Weight of oil consumed corrected for moisture—lbs.	11699	14008
36.	Vol. of moisture free oil consumed—bbls	34.5	41.56
	Fuel: Average per Hour—		
37.	Oil consumed per hour as fired—lbs.	1480	1409
38.	Oil consumed per hour corrected for moisture—lbs.	1462	1401
39.	Volume of dry oil consumed per hr—bbls	4.31	4.15
40.	Oil per hour corrected for moisture per cu. ft. of furnace volume—lbs.	2.195	2.1
41.	Oil per hour corrected for moisture per sq. ft. of heating surface—lbs.	.24	.23
	Water—		
42.	Total wgt. of water fed to boiler—lbs.	156974	180240
43.	Factor of evaporation	1.19	1.244
44.	Equivalent evaporation from and at 212°—lbs	186799	224218
	Water: Average per Hour—		
45.	Water evaporated per hour—lbs.	19621	18024
46.	Equivalent evaporation from and at 212°—lbs.	23350	22422
47.	Equivalent evaporation from and at 212° per sq. ft. of water heating surface—lbs.	3.84	3.69
48.	H.P. developed A.S.M.E. rating—H.P.	676.7	650
49.	Builders' rated H.P.—H.P.	645	645
50.	Percentage of builders' rating developed—%	105%	100.8%
	Economic Results—		
51.	Water evaporated under actual conditions per lb. of oil as fired—lbs.	13.256	12.79
52.	Equivalent evaporation from and at 212° per lb. of oil as fired—lbs.	15.775	15.91
53.	Equivalent evaporation from and at 212° per lb. of oil corrected for moisture—lbs.	15.967	16.01
	Efficiency—		
54.	Efficiency of the boiler—%	83.66%	83.13%
	Analysis of the Dry Gases by Volume—		
55.	Sample taken from gases leaving 1st pass at	L	L
56.	Carbon dioxide (CO_2)—%	13.05%	13.5%
57.	Percentage of excess air above amount theoretically required—%	18%	14%

RELATION BETWEEN WEIGHT AND OUTPUT OF INDUSTRIAL MOTORS.

Many inquiries have come in of late from readers of the Journal asking what relation exists, if any, between weight and output of industrial motors. Correspondence has been undertaken with all the leading manufacturers regarding the matter. The fullest and most comprehensive data were received from the Westinghouse Electric & Mfg. Co. and it is largely through the courtesy of this company that the following data are available on this interesting subject:

The power developed by a motor depends upon its torque and its speed. If the torque (T) be given in pounds at one foot radius, the horsepower can be calculated by the following formula:

$$\text{H.P. equals } \frac{T \times rpm}{5250}$$

For a given construction, the size, dimensions and weight of the motor parts must be proportional to the torque. The horsepower developed at any torque is proportional to the speed. For a given full-load torque a direct current motor of a given construction will weigh approximately the same independent of the speed and horsepower. For instance, a 10 h.p. motor at 500 r.p.m. will ordinarily be built upon the same frame as a 20 h.p. motor at 1000 r.p.m. and the weights of the two machines will be practically the same. Torque is therefore the most logical basis for comparing weights of direct current machines.

With a consistently designed line of motors a curve showing the relation between weight and square root of torque, when plotted on rectangular coordinates is smooth and nearly a straight line. In the case of induction motors this is true if a line of motors of given number of poles and frequency is considered. This method will be employed in showing the relation between weight and output of direct current and induction type industrial motors.

PART I.

Direct Current Motors.

Curve 1 shows the relation between weight of bare motor, i. e. motor without rails or pulley, and the square root of torque. The upper curve shows this relation for motors having cast iron frames and without auxiliary poles (Westinghouse type S motors). The lower curve shows the same for a line of motors having rolled steel frames, pressed steel feet and having auxiliary poles, representing a new departure in the construction of d.c. machines (Westinghouse SK motors). In tables I and II are tabulated values used in plotting curve 1, and in table III are values used for all other curves.

At first sight, the light weight of SK motors may seem to be obtained by economizing too much in material. This, however, is not the case; the light weight is due entirely to the inherent characteristics of the motor and the quality of materials used in its construction.

The principal object of making interpole motors is to improve commutation. Among other things, commutation depends on:

TABLE 1. CAST IRON FRAMES. D.C. SHUNT WOUND MOTORS, 200 VOLTS.

Rating. H.P.	R.P.M.	Square Root of Full Load Torque.	Weight Pounds.
2	1200	2.96	295
5	1300	4.5	400
7½	975	6.35	615
8	835	7.1	815
15	1000	8.88	1115
15	725	10.4	1500
20	650	12.75	1940
25	630	14.40	2460
300	600	16.20	2935
35	575	17.9	3230
40	550	19.6	4230

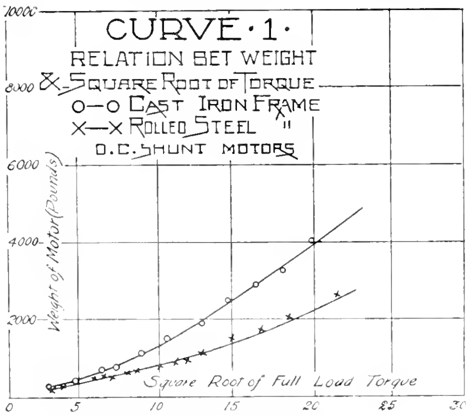
TABLE 2. ROLLED STEEL FRAMES. D.C. SHUNT WOUND MOTORS, 230 VOLTS. RATINGS AND WEIGHTS.

Rating. H.P.	R.P.M.	Square Root of Full Load Torque.	Weight Pounds.
2	1200	2.96	180
3	1100	3.78	250
5	1100	4.9	325
7½	1150	5.85	440
7½	975	6.36	460
10	1150	6.84	500
10	850	7.85	600
15	1100	8.45	665
15	825	9.74	790
20	900	10.8	895
20	750	11.8	985
30	975	12.7	1115
30	725	14.7	1460
40	775	16.5	1740
40	600	18.7	2040
50	565	21.6	2600

1. Ratio of the number of armature ampere-turns to the number of field ampere turns.

2. Air gap.

For good commutation a non-interpole motor must have a strong field, i. e. a large amount of copper on the field poles and a large cross section of magnetic circuit. The counteracting ampere turns produced by the armature current must be comparatively small; hence, the number of turns on the armature must be



Graphic Relation Between Weight and Output of Direct Current Motors.

kept down. The air gap must also be large so as to offer sufficient reluctance to the magneto-motive force produced by the armature ampere-turns and to produce a stiff field, i. e., a field not easily distorted by armature reaction.

In an interpole motor, however, the armature ampere turns are counteracted by the interpole windings. More armature turns, a smaller air gap, lighter field coils, and smaller cross section of the entire magnetic circuit are, therefore, possible. The reduction in the cross section of the magnetic circuit does not effect the rigidity of the motor, since the section necessary for magnetic purposes is far in excess of that required for mechanical strength.

All these principles have been utilized in the design of Westinghouse SK motors. With a slightly decreased air gap and the use of interpoles and pressed steel feet, the weight of the motor has been considerably reduced below the weight of the older type of motor, without sacrificing electrical performance or mechanical strength.

LABOR DISPLACING MAGNETS.

Illustrative of the different viewpoints human beings have regarding the progress of a great industry and the results thought to be brought about in the advancement of the race, we print the following from the Social-Democratic Herald of Milwaukee, a Socialist organ. Our own views will be found on the editorial page.

Magnets! Lifting magnets! These labor-saving—or rather labor-displacing devices have been on the market for about four years, but their importance in reducing the number of names on the pay rolls of the capitalists' institutions have been realized only within the last twelve or eighteen months. But within that time their introduction has added thousands of men to the army of unemployed and within the next two years their further use will add tens of thousands to the already overcrowded army.

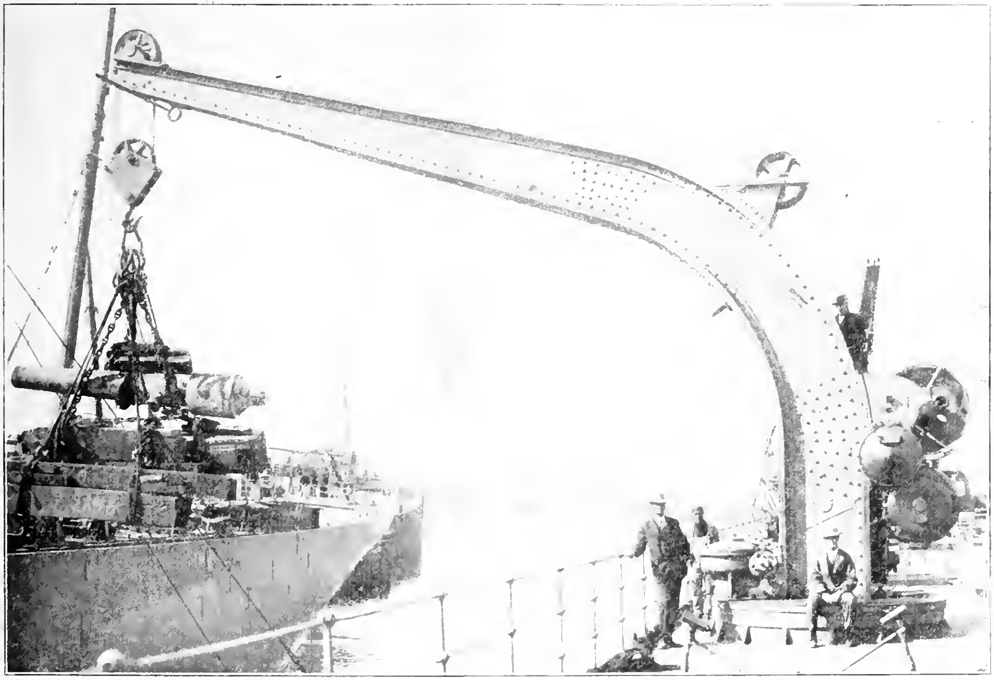
One day last May, Ralph Korngold of Los Angeles, Cal., and the writer watched two of these lifting magnets unloading scrap and pig iron at the Homestead plant of the Carnegie Steel Company.

"Those two young men operating the two magnets from the cages of those traveling electric cranes are now doing the work it formerly required twenty-five men to do," said the foreman of the department in reply to an inquiry.

Further inquiry developed the fact that the two young men operators of the cranes and magnets did the work so rapidly that they were employed only part of the time, while the twenty-five men who formerly did the work were employed all of the time.

In fourteen other parts of the works we found the same kind of magnets had performed the same kind of service in the way of decreasing the pay roll lists, which in cold figures means that twenty-eight men are now employed part of the time, where formerly it required 350 workers to remain constantly on the job. And the end is not yet, for more and more of these labor-displacing and increased profit-making devices are to be installed in other departments of the mill.

The following week we made a visit to the plants of the Crucible Steel, the American Steel and Wire, Mackintosh & Hemple, National Tube, Jones & Laughlin and other companies in the smoke belt, and the magnets at all of these places were in evidence equally as strong. At the South Side works of Jones



Magnets! Lifting Magnets!" The Kind of Derrick Displaced by New Electric Device

& Laughlin the superintendent of one of the departments made this startling statement:

"A few years ago, not farther back than 1907, the employing capacity of these works was 10,000 men. Now we can turn out more material with 4,000 than we formerly could and do the work cheaper, too."

"What became of the 5,000 men?" he was asked. "God, I don't know. We put a machine in the brass-finishing department last week and it put eighteen skilled workers out of jobs. And we shall never need them again to do that kind of work. Why if this thing keeps up we shall not need men at all to run the mill. At least not many. The engineers are constantly figuring on labor-saving devices. We scarcely need any skilled men any more. The machine has the brains and any kind of a man with ordinary intelligence can make the machine do the work. I tell you the men around here are getting scared. They can see their opportunity of having jobs becoming more insecure every day. This certainly is the age of invention in the way of labor-saving devices. That is about all the bosses seem to be thinking about these days."

The first day in June the writer, in company with Alexander Irvine of New York, went to see the exhibit at the Western Exposition building at Pittsburg, where we found on view all kinds of new machines for the benefit of the delegates to the American Foundrymen's Convention. There we saw magnetic separators, wood-carving machines, improved lathes, adding machines, sand-mixers, improved sand molds, etc., all of which were on the market to be sold to the foundrymen, coal operators, and owners of steel plants and big machine shops, the inducement to buy always including the argument that "their use would decrease the pay roll list and increase the profits."

In this great machinery exhibit we found one of the labor-displacing lifting magnets. It was a sixty-two-inch affair and the salesman in charge of this display advanced the information that the harmless looking device was capable, when connected with an electric wire, of lifting from ten to fifteen tons. One of the magnets was connected with a crane that had been erected between the two buildings at the exposition grounds, and by the simple movement of several levers operated by one man it was demonstrated that scrap and pig iron could be lifted and deposited at the will of the operator.

Literature supplied by the exhibitor showed that two of these labor-displacing magnets had unloaded 4,000,000 pounds of machine pig iron in ten hours and thirty minutes. This record was made in unloading the steamship Erwin L. Fisher at the blast furnace ore dock of the Island Steel Company, one of the subsidiaries of the steel trust, at Indiana Harbor, Ind.

The steamship docked at 7:15 a. m., and the work of unloading began at 7:35 a. m. and was completed at 6:35 p. m. The boat cleared at 7:20 p. m. the same day. As work was suspended for thirty minutes at noon the actual time for unloading was only ten and one-half hours.

Before the introduction of the magnets it required the services of twenty eight men working two days and two nights to unload a boat of this capacity. Now

two operators stationed in the cages of the traveling cranes do the work in less than eleven hours, and the only assistance they get is from two laborers during the last two hours of the unloading, these men getting the pig iron in better position at the bottom of the hold of the vessel.

It can also been seen that the saving is not confined to the twenty-four or twenty-five men actually displaced in the unloading operations. Formerly when it required the services of many men from fifty to sixty hours to unload the cargo, the sailors, firemen, engineers, electricians and others who make up the crew of the vessel, took a generous rest and found time to get acquainted with their families and friends in port. At the same time they knew they were being carried on the pay roll. But when the magnet came along the owners of the ore-carrying steamer decided that loafing on the part of its crew was a useless expense and now one vessel's usefulness under former conditions is made to do the work of two boats, and at the same time do the work at less expense. This means that the hours of the workers for rest have been decreased, and not so many men will be required at the ship yards.

So the Socialists in Milwaukee in more ways than one are hastening the day of emancipation. And when will be the day for that emancipation? This question I asked of Comrade Irvine. And his answer was:

"Just as soon as the workers own the magnet."

Was his answer right? It is for the working class to answer at the ballot box.

FARM ENGINEERING.

Recognizing that much remains to be accomplished by applying good engineering to farm operations and to the work of land development, the management of the American Land and Irrigation Exposition, to be held at Madison Square Garden, November 3 to 12, has appointed Putnam A. Bates, a consulting engineer who has specialized in these subjects, to direct the assembly of exhibits in this division of the Exposition. It looks forward to this feature as one of the most important of the entire Land Show, and believe it will throw new light on farming methods.

The country, especially in the farming districts, is dotted with water powers, once in active use for milling purposes, but which the farmers now allow to run to waste. In one instance where the farmer was wise enough to utilize this power for an electric plant, he discovered that a four-horse-power dynamo would run sixty ordinary lights, drive a milk separator, milk the cows, turn a grindstone, a fanning mill or feed grinder, cut the ensilage, and drive a dozen other small machines. He calculated that it did the work of three hired men, besides lighting the local church and his house and stable. City comforts are fast invading country villages, as is proved by the fact that in 1909, out of 5577 central stations supplying villages and cities with power, 4357 existed in towns of less than 5000 inhabitants.

PRIMER OF APPLIED THERMODYNAMICS.[1]

SEVENTH LECTURE.

Moisture and Steam Calorimetry.

In our last lecture we found that in order to compute the efficiency of a boiler or arrive at the so-called factor of evaporation, it is always necessary to know the total heat of steam. In the case considered in the last lecture, the steam was superheated, hence we knew absolutely that no moisture could exist in the steam. When saturated steam is used, however, a large quantity of fine water particles is often suspended in the steam. When this is the case, it is evident that it would be incorrect to say that the total heat per lb. of steam is the sum of the heat of the liquid and latent heat of evaporation without making some allowance for the water which has not been evaporated and which consequently represents no latent heat. Suppose for instance we have saturated steam at atmospheric pressure, and 10% of this steam is composed of water particles. Evidently then for every pound of this mixture only 90% is in reality in the form of steam. Instead of 970.4 B.t.u. being required to form a lb. of the mixture, but .90 of 970.4 B.t.u. are required. In other words to raise a lb. of water from 32° F. to 212° F. requires 180 B.t.u., and to form the vapor in this case, an additional 873.4 B.t.u. are necessary, requiring in all 1053.4 B.t.u. instead of the usual 1150.4 B.t.u. Generally speaking then, if we have x proportion of the vapor as dry steam the heat required to raise 1 lb. of water from 32° F. to steam is $(x L + h)$ B.t.u., where x is the proportion of dry steam, L the latent heat, and h the heat of the liquid.

Practically all saturated steam contains water, varying in amount from a fraction of one per cent where the steam is generated in a properly designed boiler fed with good water, to five per cent, or even more, when the feed water is bad, or the boilers are of defective design. Not only is the heat absorbed by raising this water from the boiler feed temperature to the steam temperature practically wasted, but the water causes further loss by increasing the initial condensation in the engine cylinder. It also interferes with proper cylinder lubrication, causes knocking in the engine, and water hammer in the steam pipe.

We have hitherto found that the heat of the liquid is the amount of heat necessary to raise water from 32° F. to some other intermediate point or in saturated steam it represents the amount of heat required to raise a pound of water from 32° F. to the temperature of evaporation of the water for the particular pressure. Roughly speaking 1 B.t.u. per degree is required. This is not strictly accurate, however. Fig. 16 is a diagram from which the liquid heat may be obtained at once with extreme accuracy, the diagram having been made from Peabody's Revised Steam and Entropy Tables. This table gives at once the quantity which must be added in addition to 1 B.t.u. per degree for any temperature. With this table combined with those given in previous lectures the

[1]A resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

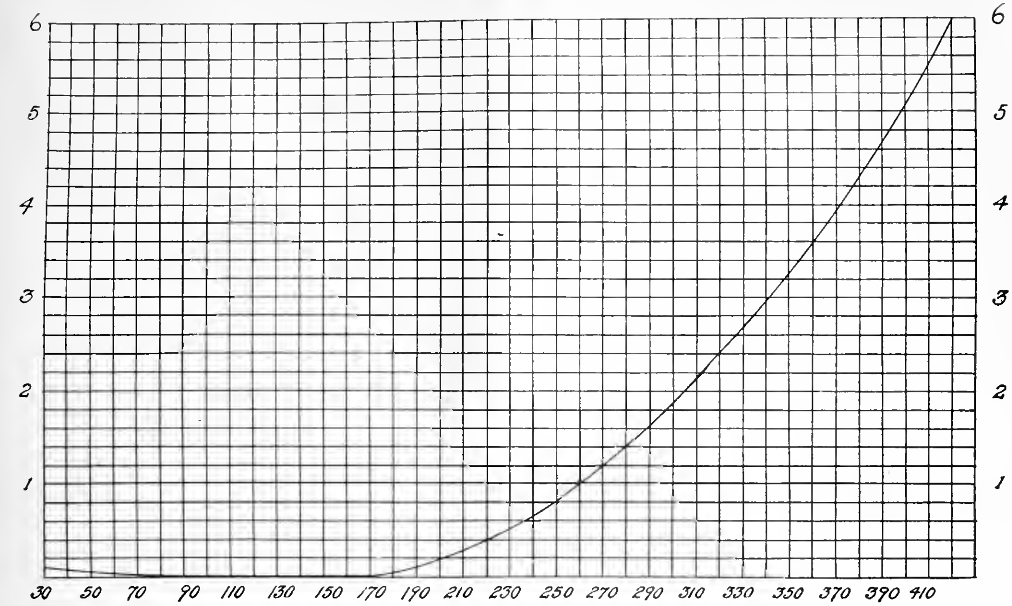


Fig. 16. Curve Showing Accurate Method of Reading Heat of Liquid. Subtract 32 From the Temperature and Then Add the Number Corresponding to the Temperature on the Chart.

student is now enabled to proceed with any problem involving steam tables.

The instrument used in engineering practice to determine the amount of water in saturated steam, or, in technical terms, to determine the "quality of the steam," is known as a steam calorimeter. The name is misleading and should not be confused with the entirely different type of calorimeter described in a previous lecture as being used in the determination of the calorific value of fuels. The several types of steam calorimeters met with in practice can be classed under five headings as follows:

1. The barrel or tank calorimeter.
2. The surface-condensing calorimeter.
3. The throttling or superheating calorimeter.
4. The chemical calorimeter.
5. The electrical calorimeter.

The design of the barrel or tank calorimeter is of simple nature, and the principle involved even more simple. A portion of the steam to be tested is passed through a hose into a barrel or tank filled with water. The weight of the water is noted before the steam is turned in, and its weight again determined after the steam application. The temperature of the water before and after the steam application is noted, and by reading the pressure of the saturated steam under observation, the list of data necessary is complete. In refined measurements, corrections for radiation and heat absorbed by the tank are made, also.

Let us suppose that the water in the tank weighs 27 lb. and that its weight is 30 lb. after the steam application is made. The water in the barrel was at 62° F. and became 175° F. after the steam application, the pressure gauge measuring the pressure of the saturated steam reading 90 lb. gauge. Let us find the quality of the steam. Now in every lb. of steam at 90 lb. gauge, or 104.7 lb. absolute, there is found from the steam tables to be 885.0 B.t.u. as latent heat and 301.9 B.t.u. as heat in the liquid. But if x lb. only are actually evaporated in every pound of mixture, the true heat which the saturated steam possesses per lb. is

$$885\,x + 301.9$$

Since 30-27 or 3 lb. of steam have been condensed in the tank, and since the tank has the temperature of 175° F., evidently the whole amount of heat given up by the 3 lb. of steam is

$$3\,(885\,x + 301.9 - 143)$$

Since the steam has parted with this heat, the water must have gained an equal amount. Hence

$$3\,(885\,x + 301.9 - 143) = 93 \times 27$$

$$\text{or } x = \frac{858.1}{885} = 0.97$$

In general we have as a heat balance for the barrel or tank calorimeter,

$$W\,(x_0 L_0 + h_0 - h_1) = w\,(h_1 - h)$$

$$\text{or } x_0 = \frac{h_1\,(w + W) - wh - W\,h_0}{W\,L_0}$$

Where

W = Weight of steam.
w = weight of water.
t = initial temperature of water.
t_1 = final temperature of water.
h = heat of liquid at t.
h_1 = heat of liquid at t_1.
P_0 = steam pressure for L_0.
L_0 = latent heat at P_0.
h_0 = heat of liquid in steam.
x_0 = proportion of steam in vapor.

The surface-condensing calorimeter is similar in principle to the barrel or tank calorimeter, with the

exception that the water does not come in contact with the steam to be condensed. As a rule, the steam is passed through a metallic coil, which is immersed in water. The steam coming in contact with the cool surface is condensed into water and is collected at the outlet and weighed, its temperature being noted. The last temperature will in general be different from the final temperature of the water in the calorimeter. Making due allowance for this difference in temperature, we can write our heat equations for this form of calorimeter as follows:

$$W(x_o L_o + h_o - h_2) = w(h_1 - h)$$

$$\therefore x_o = \frac{w h_1 + W h_2 - w h - W h_o}{W L_o}$$

in which letters have same meaning as in former calorimeter description, and

t_2 = final temperature of steam
h_2 = heat of liquid in condensed steam.

The two types of calorimeter are not extremely accurate as they are liable to so many sources of error. The so-called throttling or superheating calorimeter is, on the other hand, extremely accurate within its range of operation. Let us suppose that we have saturated steam at 200 lb. absolute pressure, and that we admit some of this steam into a chamber and so throttle the valve controlling the entrance of the steam into this chamber that its pressure is kept fairly low—say atmospheric pressure of 14.7 lb. per sq. in.

Let us suppose that 3% of the saturated steam is moisture. At 200 lb. pressure, from the chart given in the last lecture, I find the latent heat of evaporation is 843.3 or for quality of .97, we have 818; and since the temperature is 382° F., the liquid heat is 354.4, thus making the total heat 1172.4. When this steam is so throttled that the pressure becomes lowered to 14.7 lb. per sq. in., the total heat is 1150.4. The difference between 1172.4 and 1150.4 is 22 B.t.u. This heat being liberated from the steam at higher pressure when reduced to lower pressure must be felt in the physical state of the steam at the lower pressure. Hence the steam must be superheated. We found in the last lecture that the specific heat of steam is a variable quantity, but let us suppose for illustration, that the mean specific heat is .48 in this case. Hence the steam would be superheated 22/48 or 45.8° F. Evidently, then, if we measure the temperature of the steam at the reduced pressure and note the two pressures we can compute the moisture in the steam, provided the steam is not so moist that all of the surplus heat is expended in evaporating the moisture without superheating it. The heat in the saturated steam must equal the heat in the superheated steam at the reduced pressure. Hence we have for the throttling or superheating calorimeter.

$$x_o L_o + h_o = H + k(T - t)$$

$$\therefore x_o = \frac{H + k(T - t) - h_o}{L_o}$$

Where

x_o = proportion of dry steam in saturated steam.
L_o = latent heat of saturated steam.
h_o = heat of liquid of saturated steam,
H = total heat of saturated steam at lower pressure,
k = mean specific heat (use .48 for first approx.),
T = temperature of superheated steam,
t = temperature of saturated steam at lower pressure.

It is seen that $x_o L_o + h_o$ must at least equal H, or we cannot determine x_o. In cases, then, of heavy moisture content in saturated steam, this form of calorimeter will not work without some additional data. If we can supply a definite known quantity of heat to the saturated steam, we can make this form of calorimeter accurate and positive for any degree of moisture. If then Q units of heat be supplied to the saturated steam, we shall have an equation as follows:

$$x_o L_o + h_o + Q = H + k(T - t)$$

$$\therefore x_o = \frac{H + k(T - t) - h_o - Q}{L_o}$$

The Barrus calorimeter makes use of this principle, and is found accurate and dependable.

Another form of moisture measuring device is the so-called separating calorimeter, which mechanically separates the water from the steam The principle usually made use of in bringing this about is to suddenly change the velocity of the steam, allowing the steam in its changed direction to pass out through small perforations. As the water is more ponderous it cannot pass through sudden changes of direction and hence it falls into a cup beneath. The water is then weighed and the steam is either later condensed and weighed, or some other device used to measure its quantity. If

W = weight of steam free from moisture,
W_1 = weight of water free from steam,

$$\therefore x_o = \frac{W}{W + W_1}$$

The chemical calorimeter makes use of the well-known quality of common salt, that it will not go into solution when dry steam is passed over it, but, on the other hand, will rapidly absorb any moisture suspended in the steam.

In the electric calorimeter, the principle is the same as in the throttling calorimeter, in which a known quantity of heat is supplied to the saturated steam. In this case, however, the heat is supplied by an electric current. Fine german silver wires are passed through the saturated steam, and the voltage and amperage noted.. If E B.t.u. be supplied in this manner, we shall have

$$x_o L_o + h_o + E = H + k(T - t)$$

$$\text{or } x_o = \frac{H + k(T - t) - h_o - E}{L_o}$$

in which 1 B.t.u. = 17.59 watts per min.

During the year 1908, H. G. Stott and R. J. S. Pigott[1] performed a test on a 15,000 kw. steam-engine-turbine unit for the Interborough Rapid Transit Company which supplies power for the New York subway. Fig. 16 shows an illustration of ingenuity necessary to put through a test of this magnitude. No previous methods had been devised to measure the quality of low pressure steam. It was found that the ordinary perforated pipe sampler which is used to tap into the steam flow was absolutely worthless in giving a true sample. It was found necessary that the sample be taken from the main without changing its direction or velocity until it is safely in the sample pipe and entirely isolated from the rest of the steam.

[1]Trans. Amer. Inst. Elec. Engs., Vol. XXIX, Part 1, Page 222.

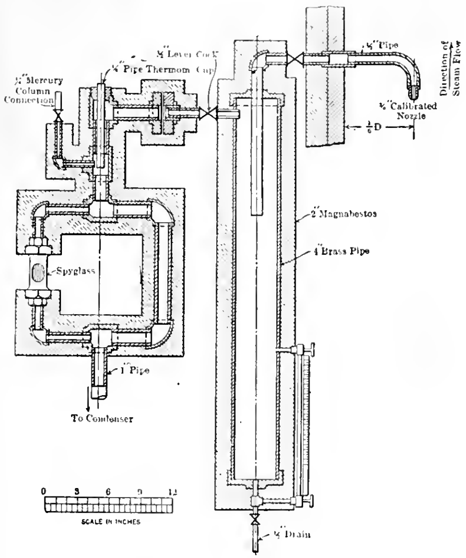


Fig. 17. A New and Accurate Method of Determining Moisture in Steam at Low Presures.

In Fig. 17, the 3/8 in. brass nozzle on the sampler is arranged to point in exactly the opposite direction to the steam flow; the lip of the nozzle is filed to a knife-edge to avoid disturbing the steam current around the sampler mouth by impact and eddies against a sensibly thick lip. If any sudden turn is made by the wet steam in entering the sample nozzle, the entrained moisture, by reason of its immensely greater specific gravity and slight skin friction will continue with unchanged direction and a dry sample will enter the nozzle. In other words, without proper care, the sampler becomes a very fair separator. The form of sampler shown in the figure takes out the sample without disturbing its direction, and the velocity can be kept correct by determining the flow from the following formula:

$$w = \frac{W a}{A}$$

Where

w = lb. per hr. flow through calorimeter,
W = lb. per hr. flow through steam main,
a = area of sampler nozzle,
A = area of main.

THERMOTWISTERS.

1. Steam at 100 lb. pressure is mixed with water at 100° F The weight of the water increases from 10 to 11 lb. and its temperature rises to 197½° F. What is the percentage of dryness of the steam?

2. The same steam is condensed in and discharged from a coil, its temperature becoming 210°, and 10 lb. of surrounding water rise in temperature from 100° to 204¼°. Find the quality of the steam. What would have been an easier way of determining the quality?

3. What is the maximum percentage of wetness that can be measured in a throttling calorimeter in steam at 100 lb. pressure, if the discharge pressure is 30 lb.?

4. Steam at 100 lb. pressure has added to it from an external source 30 B.t.u. per pound. It is throttled to 30 lb. pressure, its temperature becoming 270.3° F. What was its dryness?

5. In the last problem, the added heat is from an electric current of 5 amperes provided for one minute, the voltage falling from 220 to 110. What was the amount of heat added and the percentage of dryness of the steam?

6. An engine consumes 10,000 lb. of dry steam per hour, the moisture having been completely eliminated by a receiver separator which at the end of one hour is found to contain 285 lb. of water. What was the dryness of the steam entering the separator?

Solution of Thermotwisters—Fourth Lecture..

1. A boiler evaporates 3000 lb. of water per hour from feed-water temperature of 200° F. to dry steam at 160 lb. pressure which corresponds to a temperature of 363.6° F. What is its horsepower?

$H = 1150 + 0.3745\ (t - 212) - 0.00055\ (t - 212)^2$, where $t = 363.6$

$$\therefore H = 1150 + 0.3745 \times 151.6 - 0.00055 \times 151.6 \times 151.6$$
$$= 1194.2 \text{ B.t.u.}$$

Since the water enters the boiler at 200° F., it has already a heat of liquid amounting to 168.2 B.t.u. Hence net heat imparted to steam by boiler is 1194.2 — 168.2 = 1026.0 per lb. Total heat imparted is therefore 3000 × 1026 = 3,078,000 B.t.u. One boiler horsepower is defined by A. S. M. E. as being such a boiler which will evaporate per hour 34½ lb. of water from and at 212° F. Each lb. of steam formed under such conditions requires 970.4 B.t.u. Hence 34½ lb. per hr. will require 34½ × 970.4 B.t.u. Therefore horsepower of boiler is

$$\frac{3{,}078{,}000}{34.5 \times 970.4} = 91.9 \text{ H.P.}$$

2. In the above problem what proportion of the whole heat in the fuel is carried away in the flue gases, if their temperature is 600° F., assuming the specific heats of the gases to be constant? The initial temperature of the fuel and air supplied is 0° F.

This problem cannot be solved directly without more definite data being given or assumptions made. Let us proceed to a general solution making necessary assumptions.

Let us assume average conditions; that is, that the boiler has an efficiency of 60%.

Energy in fuel per hour is then

$$\frac{3{,}078{,}000}{.60} = 5{,}130{,}000 \text{ B.t.u.}$$

Fuel supplied we will assume has calorific value of 14,000 B.t.u. per lb.

Hence lb. of fuel required per hr $= \dfrac{3{,}078{,}000}{.60 \times 14{,}000} = 366.4.$

To thoroughly consume each lb. of coal requires about 16 lb. of air. Hence 17 lb. of gas will be formed.

Hence total gas escaping per hr. is

$$\frac{3{,}078{,}000 \times 17}{.60 \times 14{,}000} = 6225.0 \text{ lb.}$$

The B.t.u. required to heat the gas from 0° F. to 600° F., assuming specific heat of .24, will be

$$6225.0 \times 600 \times .24 = 897{,}000 \text{ B.t.u.}$$

Hence proportion of whole heat in fuel carried away is

$$\frac{897{,}000}{5{,}130{,}000} = 17.5\%. \quad \text{Ans.}$$

3. In the second problem, what would be the percentage of saving due to an economizer which reduced the gas temperature to 400° F?

Actual saving per lb. of gas escaping =

$$(600 - 400) \times .24 = 48 \text{ B.t.u.}$$

Since there are 6225 lb. of gas escaping per hr., we have

$$48 \times 6225 = 299{,}000.$$

Since total heat given out by fuel is 5,130,000 B.t.u. the saving is

$$\frac{299{,}000}{5{,}130{,}000} = 5.83\%$$

Figuring on basis of actual B.t.u. delivered in the boiler, the saving becomes

$$\frac{299{,}000}{3{,}078{,}000} = 9.71\%$$

EXAMINATION FOR APPOINTMENT TO BUREAU OF STANDARDS.

The United States Civil Service Commission announces an examination on October 25-26, 1911, at the usual places, to secure eligibles from which to make certification to fill vacancies as they may occur in the position of aid, Bureau of Standards, Department of Commerce and Labor, at salaries of $600 and $720 per annum. Men only will be admitted to this examination. Graduation from a mechanical training, technical, or scientific school, or equivalent training in scientific or technical laboratories, is a prerequisite to appointment from this examination.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

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CONTENTS

Gathering Statistics

It is a true saying that every man is a debtor to his profession, for by it he lives and for the most part has his material being. The antiquated idea of the alchemist, who through years of utmost secrecy, through years of hard work and perseverance, failed in his attempt to accomplish any fruitful results, is a typical example of the futility and barrenness of the secrecy idea. Man is of necessity a social being and must depend largely on his fellows for any degree of success in life.

One of the greatest privileges a technical publication enjoys is that of being a medium through which valuable data and statistics can be collected.. Scarcely a day passes without bringing inquiries from some of our readers regarding power installation in the West. The Journal in the past years has amassed much valuable information along these lines. Eastern technical publications have likewise accomplished much. The Journal is at present preparing a letter which in time will be sent to every power plant manager in the west. Such information as we have on hand will be filled in for his verification, and he will be asked also to fill in vacant lines not covered by our present files. We do not hope to make this compilation in a minute. It will take months and perhaps years, but real value will be attached when so collected. Its publication from time to time will spread knowledge of practice and design that can be obtained in no other way. The data will always be readily accessible to any of our readers upon application.

The frank and open-hearted manner in which these requests have thus far been met by power managers assures us of their hearty support and co-operation.

Advertising Electricity

On page 346 will be found an article by W. H. Hodge, Jr., advertising manager of the H. M. Byllesby Co., on advertising electric service. The article is interesting in that it calls to mind the fact, that in the west the full effect of proper and consistent advertising on the part of the public service corporation, is not keenly felt. For instance, in the last issue of the Journal appeared an account of the investigating department maintained by the San Diego Consolidated Gas & Electric Company. The reader is shown the care and the painstaking energy employed to meet all complaints which come in from their consumers. The enormous reduction in percentage of complaints is the best evidence that the management is being many times repaid for the time and money outlay. Other corporations in other cities undoubtedly have effective complaint bureaus. The public should be informed of the efficient methods used, and less talk about the public-service octopus trying to crush out the life of the dear public will be heard.

Again, the idea is very prevalent in many of the smaller municipalities that because a company is per-

haps the only one serving the community, it is but waste of time to advertise, for the customers will come in and sign up of their own accord. A manager working on such an hypothesis has failed to grasp some of the fundamental characteristics of his fellow-men. One of the characteristics he has failed to grasp is that ninety-five per cent of his fellow citizens are so infernally engaged in pursuing the almighty dollar they have no time to even consider a little theory and experimental data showing conclusively where money is lost often faster than they run it down by neglecting to change lamps at the end of their useful period, and by disregarding a proper and scientific installation of a few modern ideas. Nor does this manager realize that his prosperous neighbor who owns the big department store is so infernally busy putting over schemes during the day for advancing his sales influence, he has not time to consider that at night the mental makeup of the human being is such that, freed from cares and worries of the day, it becomes in a wonderfully receptive mood, ready to receive suggestive ideas. In a word such a manager has failed to place electric signs and thereby to utilize energies wasted during off-peak hours. His more progressive friend in the neighboring town by alert advertising has educated his customers in the use of the electric sign, thereby returning the money expended many times over by increased business sales and at the same time putting his newly organized public service corporation on a firm dividend-paying basis.

Is it a Knock or a Boost?

The clipping on "Lifting Magnets" appearing in these columns, on page 352, was sent us recently by one of our eastern readers, with the silent but impressive query attached: "Is it a knock or a boost?"

It is not the purpose of these columns to delve into subjects of a political nature. Hence it makes no difference where or by whom the lines were pènned, be he socialist, republican, democrat or insurgent. The jilt carefully framed against invention in the article referred to strikes deeper than party or creed. It strikes at the very fundamental makeup of modern civilization—nay, it strikes still deeper—even at the very why and wherefore of our creation. It silently asks the question whether the fruits of the struggle of brains and industry are after all worth while.

Only the Almighty, himself, can answer such profound questions. We come into this world naked and bare and when mature age arrives find ourselves born to earth and bound to earth. In this beautiful, happy world of ours, if we do not have the proper focus on its makeup, we pass up and down the mournful streets, view the sorrows, the disappointments, the shabby pretense, the struggle on all sides for the elusive phantom known as happiness, and, were it not for that inborn indescribable something which spurs us on, giving hope and promise of things better for the future, we might well drop out of the race before the ring of the starter's pistol-shot dies away..

But there is something within us that spurs us on, something that gives hope and promise in the sound of children's voices in the clamor and clanging of a busy industry, in the realization that by struggle of brains and intellect the final outcome of invention will raise the human race to the level of the great creator himself, and thus work out the unsolved problems of the ages.

The rapidity with which the products of invention have taken over the burdens of mankind has had a tendency at times to unbalance certain supply and demand relations in the labor problem. During a period thereafter unquestionably distress and want are felt until the readjustment of affairs can once again be brought about. The experience of the past has demonstrated that in time the re-adjustment is complete. Although the advent of the cotton-gin, the sewing machine, and the myriad other labor-saving devices, temporarily displaced thousands of laborers, eventually they so increased the demand for manufactured products that even tens of thousands are today employed in the same industries. Our patent laws are so drawn that all monopolies of patent ideas in time are annulled and the inventions become the free property of the people, and by application of these ideas and still further refined inventive additions, the human race will be immeasurably raised above our shivering, cave-dwelling ancestors of the stone age into a plane approaching equality with that of the great creator of all things.

As for us practical, everyday working men, let us remember that while we are engaged in this busy struggle, this struggle of advance through brains and intellect, let us not forget that the very effort itself is making for each individual so engaged an inner happiness in thorough harmony and synchronism with the inborn spark of life. Whether the ultimate aims will be reached is immaterial for happiness. We can but live in the present day before us, and the cynic can content himself when living in this way, with the philosophy of Shakespeare, which tells us, "That all things that are, are with more spirit chased than enjoyed."

But for the optimistic being!!

Let us work and work and work. Let us build into our great Western Empire the wholesome spirit that has always pervaded its very god-given freedom and promise. Let us unselfishly work for progress, work for invention, work for all things that are good and wholesome, and let us find our reward in the words of Kipling:

> "And only the Master shall praise us, and only the Master shall blame;
> And no one shall work for money, and no one shall work for fame,
> But each for the joy of the working and each in his separate star,
> Shall draw the Thing as he sees It for the God of Things as They Are."

PERSONALS.

J. W. White, of the Fort Wayne Electric Works' sales department, is on a tour of Nevada.

F. B. Gleason, manager of the Pacific Coast branch of the Western Electric Company, is at Los Angeles.

R. D. Holabird, president of the Holabird-Reynolds Company, leaves on Saturday for an Eastern trip.

Harry Tittle, superintendent for the John G. Sutton Company, returned from Vancouver during the past week.

F. H. Poss, Pacific Coast manager for the Holophane Company and the Benjamin Electric Company, is at Los Angeles.

R. S. Buck, of the firm of Sanderson & Porter, is again at New York, after spending some time in Idaho on engineering work.

F. O. Alton has arrived from the East and joined the motor sales department of the General Electric Company's San Francisco office.

George Cole, of the John R. Cole Company, is expected to return from a month's visit to the Eastern factories about November 1st.

F. W. Gay, of J. G. White & Co.'s engineering staff, has returned to the San Francisco office after spending several weeks at New York.

O. K. Jones, formerly an inspector in the San Francisco Department of Electricity, has joined the sales department of the Aylsworth Agencies Company.

Carl M. Bernagen, president of the Keuffel & Esser Co., manufacturers and distributors of mechanical drafting instruments, is making a tour of the Northwest.

Herbert Smith of the Safety Insulated Wire & Cable Company, is visiting the Eastern factory. E. A. Freeman recently joined the company's San Francisco sales force.

Rudolph W. Van Norden, consulting engineer, has returned to San Francisco from an inspection of the Coleman plant of the Northern California Power Company.

Thomas Mirk and K. G. Dunn, of Hunt, Mirk & Co., are at San Diego on business connected with the extension of the San Diego Electric Railway Company's power plant.

S. L. Sinclair, a recent arrival from Pittsburg, has joined the sales force of the Westinghouse Electric & Manufacturing Company, to fill the position of H. F. Fisher, resigned.

Jack Hyer, formerly connected with the municipal electrical inspection department, has returned to San Francisco from an Eastern trip and taken up an agency for electrical goods.

Hans Pederson, contractor, Seattle, who is constructing a portion of Tacoma's Nisqually power plant, announces that he will soon begin pouring concrete for the floor base of the reservoir at La Grande.

John L. Hartman, president of the Atlas Foundry & Machine Company, of Tacoma, after an enjoyable three months' Eastern tour, is at home again and prouder than ever of prospects in the Northwest.

S. Wyman Rolph, manager of the Holabird Electric Company of Seattle, is now at San Francisco, and is receiving the congratulations of his friends on the arrival of a new son at the family home at San Mateo.

E. A. Heron, president of the Oakland Railway Co.; W. R. Alberger, vice-president and James Potter, superintendent, are in the East on business. The latter is attending the National Street Railway Convention at Atlantic City, N. J.

H. F. Fischer has resigned from the sales department of the Westinghouse Electric Manufacturing Company to accept a position in the electrical engineering department of the University of California at Berkeley.

Edward Sawyer, president and general manager of the Atlantic Insulated Wire & Cable Company, spent the past week at San Francisco with Hand & Jones, the Company's Coast representative. Mr. Sawyer is returning East by way of Portland, Seattle, Spokane and Butte.

Robert Edwards, Jr., affectionately called "Bob" and "Major," by his personal and business acquaintances, and one of the most prominent men in the electrical field, has recently acquired the control of Edwards & Company.

A. C. Wales, who has been San Francisco manager for the Nernst Lamp Company for the past four years, will leave for the East next week to become manager of the Chicago branch. Ira J. Wolfe, formerly cashier, has been promoted to the management of the company's San Francisco office.

C. L. Cory, Dean of the Mechanics College of the University of California, acted as the jovial toastmaster at the recent banquet of the Associated Mechanical and Electrical Engineers of the State University. The organization comprises the two upper classes in mechanical and electrical engineering.

E. H. Coolidge, general commercial superintendent of the Pacific Telephone and Telegraph Company; C. W. Burkett, general superintendent of plant, and D. P. Fullerton, division superintendent of plant, have returned to San Francisco after making a 900-mile automobile inspection of Central Nevada with a view to future extensions.

Harry T. Cory, civil engineer and brother of the well known consulting engineer, C. L. Cory, has taken unto himself a bride. Mr. Cory was thought to be bullet proof, but the personal magnetism of southern California has proved the victor and reports from south of Tehachapi indicate he is not only to be forgiven for violating the vows of celibacy, but sincere congratulations are in order.

George J. Henry Jr., engineer for the Pelton Water Wheel Company, gave recently an interesting after-dinner speech at the annual banquet of the Associated Mechanical & Electrical Engineers of the University of California, in which he depicted many amusing incidents met with by the engineer in gaining practical experience after graduation. Mr. Henry is a graduate of the University of California..

ELECTRICAL CONTRACTORS' NOTES

Frank Somers, manager Century Electric Company, San Jose, was in San Francisco recently.

Noble Powell of Stockton was in San Francisco recently and says that a great deal of small work is being done in Stockton.

C. V. Schneider, manager of the Electric Supply Company of Sacramento, is in San Francisco and reports business good in Sacramento.

Charles E. Sloan, of Sloan & Robson, has returned to San Francisco from Alturas, Modoc County, where the firm has had charge of engineering work.

H. V. Reid, manager electrical department of the Pacific Fire Extinguisher Company, has just returned from Portland, where he signed up a large electrical contract.

The electrical work is now being figured for the new Mount Zion Hospital, at Fulton and Devisadero streets. The estimates are in the neighborhood of $15,000

Figures are being taken for the electrical work on the Downtown Realty Theatre, at Eddy and Mason streets. It is estimated that about $15,000 will be spent on electrical wiring and apparatus.

Cunningham & Polito are taking bids for wiring on Ike Kohn's new reinforced concrete building on the corner of Van Ness avenue and Sutter street. The estimated cost of the electrical work is about $5000.

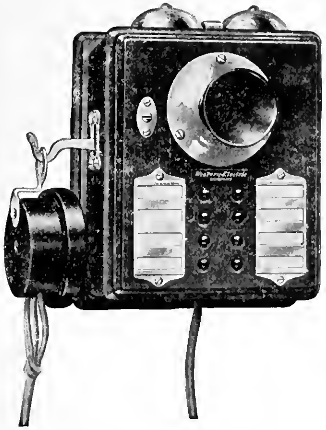
"Pop" Boynton, manager of the Central Electric Company, of Los Angeles and San Francisco, has just returned from the south and is busy explaining to his friends that it was business and not baseball that took him south. "Pop" rarely misses a game. He reports business good in the south.

INDUSTRIAL

A NEW FOUR AND EIGHT-BUTTON INTER-PHONE SET FOR SELECTIVE RINGING, COMMON TALKING, PRIVATE LINE SERVICE.

The Western Electric Company recently placed on the market a new line of inter-phones which will fill a long-felt want in residences, factories, schools and mercantile establishments where intercommunication between stations is not so frequent as to require separate lines.

These sets are arranged for selective ringing, common talking service, that is, any station may call any other station without interfering with any of the others. These sets are designed for use where conversation between two parties at one time is all that is required. They will give just as satis-



Improved Type of Interphone Set.

factory service as the individual-line type gives on large 24-line systems, where often two or more conversations are necessary at the same time. They are made in capacities of four and eight buttons, which will accommodate five and eight parties, respectively.

Fig. 1 shows the eight-button set, known as the No. 1327-L. This is a non-flush wall set, but a desk type is also furnished when desired. The standard finish for the 1327-L type sets is oak, but other wood finishes can be supplied to order. The instrument through compact is not crowded, and the apparatus is arranged so as to make installation easy, as only one set of batteries is required for the whole system. The instruments are so simple in construction that there is little chance of their getting out of order, and the maintenance expense of the system is practically negligible. This system is recommended where a simple yet reliable means of communication is required at a low cost.

ROTARY CONVERTERS FOR MINING SERVICE.

Rotary converters are being nsed in many coal and metal mines. Direct current is necessary for the operation of mining locomotives because alternating-current motors cannot satisfy the speed and space requirements. Alternating current is used for the transmission of the energy from the steam or hydroelectric generating stations to the mines, and the rotary converter is the logical machine for efficiently converting the alternating to direct current at the point where the energy is to be used.

Several public service companies in both Pennsylvania and in Colorado are making a specialty of supplying mines with alternating-current energy and are developing excellent mining loads. The larger mining companies find it economical to establish steam or hydraulic generating stations at points where energy can be generated cheaply and to transmit

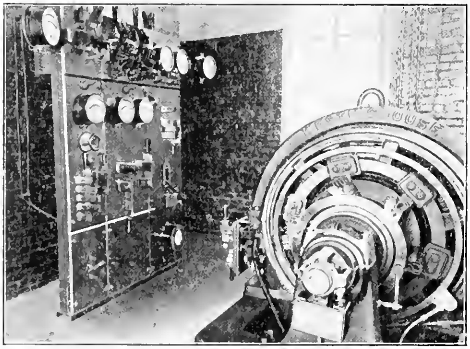


Fig. 1. Rotary Converter Substation at Mine No. 22 of the Consolidated Coal Co., 150 kw., 275 volts direct current, 3 phase, 60 cycles, 1200 r.p.m., rotary converter.

it as high-tension alternating current to the mine or group of mines where it is utilized. Whether alternating energy is generated by a public service company or by the mining company, experience shows the rotary converter to be an efficient, reliable machine for converting the alternating to direct current. A nominal voltage of either 275 or 600 is adopted for the direct-current distribution systems within the mines.

A good example of a mining plant rotary converter installation is shown in Fig. 1, which is a view of the snbstation at Mine No. 22 of the Consolidated Coal Company of Pennsylvania. This station received energy as alternating current at 2300 volts, three phase, 60 cycles. The pressure is stepped to 158 volts for the alternating side of the Westinghouse 150 kw. rotary and is delivered therefrom as direct current at 275 volts. A standard Westinghouse black marine finished switchboard, carrying the usual switch gear and instruments, controls the incoming alternating-current line, the rotary converter and the outgoing direct-current feeders, which radiate to different parts of the property.

TRADE NOTES.

The Vancouver Lumber Company of Vancouver, B. C., have recently placed an order with the Allis Chalmers Company for one 750 kw. low pressure turbine and a number of motors for their planing mill at Vancouver.

The Agutter Griswold Company of Seattle have been awarded the contract to do the wiring and furnish the necessary switchboards for the new 42-story Smith Building, to be erected in Seattle. Work on this building has commenced.

The British Canadian Lumber Company of Vancouver, B. C., have just completed plans and specifications for their new mill they are to build. The electrical requirements will include a 1500 kw. generator, a number of motors and switchboards.

Machado & Roller of New York City, whose Pacific Coast representatives are Otis & Squires, of San Francisco, have taken the sole agency in this country for the Columbia high

torque induction meters. Otis & Squires will have a full stock of both this house and switchboard types.

Among orders recently received by the Railway Department, General Electric Company, Schenectady, N. Y., is that of the Pacific Electric Railway Company, Los Angeles, Cal., for 1 motor generator set; 1 17 kw.-500-125 v. exciter; 3 WC. 60-540-15000/13500-2250 v. Core type transformers.

McDonald & McDougal, railroad contractors who have the contract for constructing the Oregon electric extension from Albany to Salem, Oregon, have established a number of camps along the right of way preparatory to active construction. One feature of the construction will be a 7000-foot bridge.

H. M. Byllesby & Company of Chicago has under construction at Albany, Oregon, the largest filtration plant in the State. The plant is for the Oregon Power Company and will be used in connection with Albany's municipal water system. The capacity will be 2,250,000 gallons of water per day and there will be 40,000 square feet of filter area.

The Pelton Water Wheel Company has sold to the Montesano Light & Water Co., a 315 h.p. cylindrical case Pelton-Francis turbine, with an extended base to carry a generator on either side. It will operate at 600 r.p.m. under a head of 65 feet and will be connected to two generators by friction clutches. The load consists of lighting and motors at Montesano, Wash.

J. C. Farrar & Co., Pacific Coast agents Electrical Engineers' Equipment Company, report the sale of twelve 25,000 volt, triple conductor cable end bells for outside service on lead-covered, steel-band armored submarine cables to the Great Western Power Company; two 13,000 volt triple conductor cable end bells for outside service to the Northern California Power Company, and a quantity of switchboard frame fittings and bus bar supports to Stone & Webster at Reno and Verdi, Nev.

Among the recent large contracts received by the Westinghouse Electric & Manufacturing Company was one granted by the commission government of the city of Tacoma, Washington, for the entire switchboard and auxiliary apparatus for the power house, substation and transmission line of the 27,000 horsepower hydroelectric plant the city is erecting. The plant is located about seven miles from the city of Tacoma on the Nisqually River, and electrical energy will be transmitted at 55,000 volts for furnishing light, power and railways in the city and vicinity.

NEW CATALOGS.

The Wheeler Condensing & Engineering Company of Carteret, New Jersey, has just issued Bulletin No. 103, which treats of Wheeler-Edwards air pumps in a very interesting and attractive manner.

The Sterling Electrical Mfg. Co., of Warren, Ohio, has just issued a series of leaflets on incandescent electric lamps of the Sterling design. The leaflets deal with descriptions and price quotations of standard lamps handled by the company.

The Electric Storage Battery Company of Philadelphia has just published the fourth edition of their hand book "IP" on the "chloride accumutator" for use in 110 volt isolated lighting and power plants. The booklet is interesting and attractive.

The Crocker-Wheeler Company of Ampere, N. J., have just published a booklet on induction motors, which clearly and concisely explains their patented magnetic bridges and how these bridges add to the motor's operating characteristics, mechanical durability and convenience.

The Shelby Electric Company of Shelby, Ohio, has an interesting catalog on Shelby Lamps. A second booklet entitled The Fortress of Lamp Quality, has also just been published, and is profitable reading for anyone interested in the development of the great lamp industry.

"Common Battery vs. Local Battery Operation for the Small Exchange" is the title of the new Bulletin No. 1017 which has just been issued by the Western Electric Company. This is one of the most interesting and instructive bulletins ever put out by a manufacturing company. It compares central and local battery equipment from a service and cost standpoint.

The Allis-Chalmers Company of Milwaukee has published an interesting series of new catalogs. Bulletin No. 1070 deals with Type B. Barometric Condensers, while No. 1519 deals with Type AN Barometric Condensers. Bulletin No. 1083 is concerned with direct current motors and generators, while alternating current generators are discussed in No. 1078. Engine driven direct current generators of types "T" and "TW" are described in No. 1082 and direct current motors and generators of type "H" and "HT" in No. 1074. Direct connected Corliss engines of the "Reliance" pattern are taken up in Bulletin No. 1068.

Very little has been done to explain to the everyday telephone user—the blacksmith, the storekeeper, especially in smaller towns and villages—the simple facts of why such and such rates were made, and why they are necessary to-day. In other words, a booklet that is of mutual benefit to operator and subscriber because it tells the subscriber the economy of better service. That is precisely the purpose of a new publication, just issued by the Kellogg Switchboard & Supply Co. It is written by a practical man, Mr. H. N. Faris, of long and wide experience in the telephone field—experience that is of great value to the operator of any size exchange.

The General Electric Company has recently issued some interesting and attractive catalogues. Bulletin No. 4859 describes the line of synchronous condensers especially adapted for floating on the line for improving the power factor. These condensers have been designed to meet the demand for a comparatively inexpensive high speed machine of this nature. Bulletin No. 4877 is devoted to direct current switchboard panels, single polarity, for small mining plants. Bulletin No. 4882 describes Enclosed Flame Arc Lamps. This lamp utilizes the impregnated, or so-called plain carbon electrode which gives remarkable illuminating efficiency. Bulletin No. 4871 describes the General Electric Company's mercury arc rectifiers for battery charging, and supersedes that Company's previous bulletin on the subject. Bulletin No. 4857 thoroughly describes its switchboard and high tension relays. Among these relays are those for circuit-opening, time-limit relays, inverse time-limit, definite time-limit, low voltage, no-voltage and over-load, reverse current, reverse phase. Bulletin No. 4873, illustrates and describes in considerable detail that company's control apparatus for steel mills. Bulletin No. 4876, issued by the General Electric Company, on small plant direct current switchboards, illustrates and describes that company's 76-inch direct current panels designed for general use in small central stations and isolated plants.

ELECTRICAL ASSISTANT.

The United States Civil Service Commission announces an examination on November 22, 1911, to secure eligibles from which to make certification to fill vacancies as they may occur in the position of electrical assistant in the Signal Service at Large, War Department, and vacancies requiring similar qualifications as they may occur in any branch of the service, unless it shall be decided in the interest of the service to fill such vacancies by reinstatement, transfer, or promotion. The salary of electrical assistants in the Signal Service at Large is $1080 per annum.

NEWS NOTES

FINANCIAL.

LONG BEACH, CAL.—Water bonds amounting to $850,000 were formally turned over in Los Angeles to the Long Beach and Alamitos water companies, the successful bidders.

SALMON, IDAHO.—An ordinance is to be submitted to qualified electors and taxpayers of the city of Salmon, on the question of incurring an indebtedness on the part of the city, in the sum of $65,000.

FALLS CITY, ORE.—Falls City has desided, by a vote of 80 for and 21 against, to issue bonds to the amount of $5000 to extend the water system, pay the indebtedness and build a fire emergency reservoir.

ASTORIA, ORE.—The Astoria Water Commission has awarded to the S. A. Kean & Co., Chicago, the $80,000 5 per cent 20-year bonds issued for the making of improvements to the water system for $80,600.

ORANGE, CAL.—The City Council has passed an ordinance calling a special election to be held November 3 for voting on the question of issuing $50,000 bonds for the construction of improvements and extensions of the city water system.

LOS ANGELES, CAL.—The City Council has passed an ordinance ratifying and confirming the sale and delivery to Kountze Brothers and A. B. Leach & Company of New York City, of $408,000 water works bonds of the city, being part of the issue of $23,000,000 bonds authorized at the special election held June 12, 1907.

LOS ANGELES, CAL.—The first step toward regulating street car fares in this city was taken this week when the Council adopted the report of its legislative committee on the subject. The Board of Public Utilities and the city attorney were empowered to prepare an ordinance which will place in the hands of the board regulation of fares. Adoption of the proposed ordinance will give the Board of Public Utilties authority to compel local street railway corporations to render reports on their earnings and the valuation of their systems.

LOS ANGELES, CAL.—The finance committee of the City Council began consideration of one of the greatest municipal ownership projects in the country. It is proposed to issue $6,000,000 in bonds for the purchase of the Pacific Light & Power Company, the Los Angeles Gas & Electric Corporation and the Southern California Edison Company, whose combined distributing systems are valued at $8,500,000 by the companies. In case the companies refuse to sell it is proposed that the city lay its own conduits and parallel those of the three companies. The city will have a surplus of 150,000 h.p. from the Owens River aqueduct, the new water plant being brought 266 miles at a cost of $23,500,000, and this energy will be used in distributing light and power to the people, it is claimed at a much less cost than is now charged by the privately owned companies.

ILLUMINATION

ALBANY, ORE.—The Council has passed an ordinance granting to W. H. Goldrich a franchise to build a gas plant here.

PASCO, WASH.—A local contractor, R. Hammond, has been awarded the contract for installing three light poles for $4098.20.

TOPPENISH, WASH.—Immediate installation of four new street lights, of 2000 c.p. each, has been ordered by the City Council.

KENT, WASH.—Residents of the East hill, E. L. Hansen, R. R. Rotter and others, have asked that gas mains be extended to their places.

ALHAMBRA, CAL.—The Board of Trustees has passed an ordinance adopting the specifications for ornamental concrete lamp posts to be erected in this city.

MEDFORD, ORE.—The contract for the installation of cluster lights on Main street, has been awarded by the City Council to the Southern Oregon Electric Company.

SEATTLE, WASH.—Roy W. Comegys has made application to the Board of Commissioners of King County, Wash., for a franchise to use certain county roads and public places in the county for the construction and maintenance of an electric light system.

ANACORTES, WASH.—According to the intention of Messrs. Julius Nelson, J. P. Benton and E. D. Nelson, this city is to have a gas plant in running order before long and have applied for 30-year franchises before the council. They purpose to put in mains and materials in all parts of the city where they can procure customers.

MARYSVILLE, CAL.—The committee appointed by the Chamber of Commerce to raise funds for the building of the electric arches on D street, have completed their labors as far as D street is concerned. Contributions amounting to $5000 have been received. The committee is now engaged in raising money to build arches of the same kind at Third and E streets, and Third and V streets.

PULLMAN, WASH.—Recent additions to equipment at the State College of Washington include a 150 kilowatt direct connected alternator, driven by a Reliance Corliss engine. This unit is available for both power and experimental use. Also a 60 h.p. Weber gas engine is being installed with both up and down draft types of producers for an extended investigation of producer gas fuels of the Northwest. Sixty-five lamp posts of neat design and equipped with series tungsten lamps are being installed for campus lighting.

INCORPORATION.

OAKLAND, CAL.—The Sacramento Short Line and the San Jose Short Line have been incorporated with a capital stock of $10,000,000 by the former and $9,000,000 by the latter, by B. M. Aikens, R. P. Henshall, Luther Elkins, G. W. Mordecai, N. Schmulowitz, R. V. Whiting and F. L. Stewart.

PHOENIX, ARIZ.—The Arizona Construction & Finance Company with home office in Phoenix, has been incorporated with a capital stock of $2,000,000. The object of the company is the operation and maintenance of an electrical street railway. The directors are R. A. Lewis, W. B. Barr and S. D. Dunlap.

TWIN FALLS, IDAHO.—Articles of incorporation have been filed with the county recorder by the Twin Falls Railway Company. The capital stock is $500,000. The incorporators are I. B. Perrine, C. Smith, D. Moorman, E. Williams, A. Stafford of this city, and R. S. Buck and Raymond McCune of New York City.

PORTERVILLE, CAL.—Articles of incorporation of the Central Counties Gas Company were filed Saturday. The capitalization is $1,000,000. This is a Porterville controlled and promoted organization, which is to take over all the gas plants of the Southern San Joaquin Valley and place them under one management. Surveying work is now being done for a

high pressure line which is to be used as the supply for Strathmore, Ducor, Terra Bella, Tulare and possibly Dinuba.

TRANSMISSION.

VANCOUVER, WASH.—Two independent cables for the transmission of 1500 horsepower will be laid under the Columbia River by the Portland Railway, Light & Power Company, to furnish electricity for this city.

SAN JOSE, CAL.—The Great Western Power Company has made application to the Board of Supervisors for a franchise to erect lines for transmitting and distributing electriicty along the county roads in Santa Clara.

CORNING, CAL.—Mr. Forbes, construction engineer of the Sierra Light & Power Company, is here going over the lines of the local plant. He is now engaged in preparing plans for the entire reconstruction of the plant and line.

SACRAMENTO, CAL.—The Great Western Power Company has been granted permission to lay an underground wire system in Third and Fourth streets, K. to L. The application was presented by Attorney Hugh B. Bradford.

THE DALLES, ORE.—The Skamania Light & Power Company of Stevenson, Wash., desires to supply The Dalles with electricity for power and lights, and should it be given the privilege will sell at half price. S. Samson is president of the corporation.

HOOD RIVER, ORE.—The Hydroelectric Company of Hood River, which is having a preliminary survey made preparatory to starting work on a power and light plant here, has extended its operations to The Dalles and has applied for a franchise in that city.

OROVILLE, CAL.—The Great Western Power Company has purchased what are known as the Reuben Stover and Thad Stover ranches in upper Big Meadows. The Stover holdings comprise over 1000 acres of land, and their absorption by the big electric power corporation indicates that it is the desire of the latter to obtain control of practically all land in that valley.

DORRIS, CAL.—Dorris is jubilant over the announcement that the Siskiyou Electric Light & Power Company expects to furnish light and power services here within sixty days. The company's line now building through here will be the first to touch the town. The sub-station has already been erected and application has been made and bids advertised for the sale of said franchise through the corporate limits of the city. A 50-year franchise is asked.

PORTERVILLE, CAL.—C. H. Holley, chief engineer, is quoted as saying that the Tulare County Power Company will be delivering power to the patrons of the line not later than the 1st of April, and that contracts for the delivery of power at that date to the stockholders, are now being written. This concern is a co-operative organization and each share of stock carries with it an agreement from the company to deliver one horsepower of electricity annually. The substation from which the power is to be delivered to the orange district will be located at Strathmore, and work on this station is to be started shortly. Location has been secured in Tulare for a station which will supply the dairy district where a steam auxiliary will be located.

TRANSPORTATION.

VALLEJO, CAL.—Within a few days T. T. C. Gregory, president of the Vallejo & Northern, will advertise for bids for the Vallejo terminal improvements, which the company will make preparatory to beginning the construction of the new electric road from the bay to Sacramento. The company owns 24 acres of tide lands and it is proposed to build a bulkhead along the entire frontage.

SAN JOSE, CAL.—C. P. Anderson has applied to the Board of Supervisors of the County of Santa Clara, Cal., for a franchise to construct a single or double track standard gauge railroad in the county of Santa Clara, to be operated by electricity or gas.

RIVERSIDE, CAL.—The City Council will receive sealed bids up to October 31 for the purchase of a franchise granting the right to construct and for a period of forty-five years to maintain and operate a double track electric railroad on certain streets of the city.

PASADENA, CAL.—Material is on the ground for the construction of a cut-off from four track lines of the Pacific Electric Railway Company at Schutzen Park, through the hills to the Cawston Ostrich Farm. The company contemplates building a tunnel 1500 feet long where the hills are pierced.

CUCAMONGA, CAL.—Paul Shoup and William Pillsbury, officials of the Pacific Electric Railway Company, have been here looking over the proposed route for the trolley line. If the officials decide on the route, a free right of way will be given from the Ontario Colony through to Etiwanda, and they will be given 1000 cars of freight from the beginning.

SAN BERNARDINO, CAL.—The proposition of the Pacific Electric Company to build a car line into the northwest section of the city on F street, from Third to Seventh street, west on Seventh to Mt. Vernon avenue, north on Mt. Vernon to the city limits, in consideration of a bonus of $18,000, has been accepted by the property owners who are anxious for immediate construction.

SAN FRANCISCO, CAL.—Construction work on the Geary Street Municipal Railroad is being pushed rapidly ahead under the supervision of Superintendent Broderick and Public Works Commissioner Laumeister. Rails have been laid in Geary street from Fifth to Thirty-second avenue, and the concreting of the roadbed is under way. The trolley wires have been stretched along Geary street from Thirty-third avenue to Kearny street and on the first of October, Tenth avenue from Fulton street to Geary, was ready for the ties and rails.

SAN FRANCISCO, CAL.—At the annual meeting of stockholders of the Northern Electric Railway Company the directors were re-elected as follows: A. E. Boynton, E. J. de Sabla Jr., W. P. Hammon, P. B. Lilienthal, E. R. Lilienthal, Joseph Sloss and Louis Sloss. The directors organized by re-electing officers as follows: E. R. Lilienthal, president; E. J. de Sabla, Jr. and Louis Sloss, vice-presidents; Norman Logan, secretary. This company was organized in 1907 as a consolidation of the Northern Electric, Chico Street Railroad, Shasta Southern Railroad, Redding and Red Bluff Railroad, Marysville and Yuba City Street Railway. It operates from Sacramento to Chico via Oroville and from Chico to Hamilton, 130 miles in all. The capitalization is $25,000,000, of which $10,000,000 is preferred non-cumulative 5 per cent; earnings are steadily increasing, and the company is in good financial condition.

WOODLAND, CAL.—At a meeting of the executive committee of the Sacramento Valley Electric Railroad, or, as it is called by some, the Woodland-Red Bluff Electric railroad, held in this city this week, Attorney A. C. Huston of Woodland was instructed to prepare applications for franchises through Yolo, Colusa, Glenn and Tehama Counties as early as possible. Another matter of interest was the partial report of Engineer Melville Dozier on the preliminary survey. At the meeting were Charles L. Donohoe of Willows, president; E. L. Sisson of Red Bluff, secretary and J. Reith Jr. of Woodland, H. H. Earl, Attorney A. C. Huston and Engineer Dozier. Preliminary proceedings for the building of the road were discussed. Dozier, in his verbal report, stated his corps of engineers, had made surveys to a point a short distance above Maxwell, Colusa County. Four lines were surveyed out of Woodland before reaching the northern boundary.

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POWER POSSIBILITIES IN THE INLAND EMPIRE

BY HARRISON WILLIAMS.

The appellation "Inland Empire" is used locally to designate a portion of the Pacific Northwest that would be more definitely designated as the geographical territory drained by the Columbia river. Few large geographical areas are as definitely marked by natural features as a territorial unit as this is. Nothing could mark such a unit more definitely than the drainage of a great river system. It is a natural economic unit.

A Typical Water Fall in the Inland Empire Illustrating the Scores of Small Water Powers to Be Found There.

The Columbia basin has an area of about 250,000 square miles, that is, the inland part, east of the Cascade range. That is 50,000 more than the area of France, and 40,000 more than that of Germany.

France and 50,000 square miles of adjoining ter-

Rainbow Falls at the Head of Lake Chelan, Chelan County, Washington, West of Spokane.

ritory on the east have a population approximating 60,000,000. Germany now has a population of about 65,000,000 in an area of a little more than 200,000 square miles. Greater Berlin in 1900 contained 2,523,461 inhabitants, and is now estimated to contain 3,400,000. In western Europe the density of population between the 49th parallel and the North Sea and the Baltic averages considerably more than 300 to the square mile.

The average on the portion between the 49th parallel and the Mediterranean is about 190 to the square mile. If we take the 48th parallel as the dividing line both Paris and Vienna will be in the north division, and the disparity will be still greater. No doubt investigation would show that in the matter of commerce and wealth the difference would be much greater, especially in the matter of commerce. Now, industries create commerce and wealth and support population, and we see by these comparisons that industries thrive best in the higher latitudes. Perhaps this is so because the higher latitudes produce "men." Anyway that, for some reason, appears to be the case.

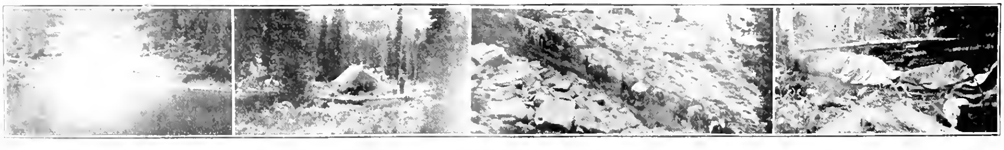
Japan proper has an area of 114,750 square miles, and in 1903 its census gave the population at 45,889,500. Japan is a very mountainous country, and the proportion of its arable land to its unproductive land is not greater if as great as it is in the Inland Empire. Any superiority there may be in productiveness—and there no doubt is superiority now—is due to better husbandry and to fertilizing. More than half of Japan's population is employed directly in agriculture.

Next to the soil itself the streams of the Inland Empire supplying water for power, navigation and irrigation, constitute the greatest natural asset, not excepting the combined mineral and forest wealth. I have seen the statement, said to have been made on the authority of the Geological Survey, that one-third of the water power of the United States is in Oregon and Washington. But there is more water power in the Columbia drainage in Idaho and Montana than there is in Oregon and Washington outside of the Columbia drainage.

The rainfall that produces the great river—two-thirds of it in the State—is the explanation of the fact that the largest body of white pine timber in the United States is in Idaho and the Columbia drainage in Montana. Any attempt to express the value of this water power in terms of money would give only a very meager conception of its importance to the community, since electricity—which can only be put under control by first harnessing the energy residing in some substance, as fuel or falling water—has become a necessity of modern society. But we can best realize its value as a purely economic asset by stating it in money terms.

The horsepower year cost of both water power and steam power takes a wide range, but the ratio is generally placed at 1 to 3. In this Columbia country the difference in cost is easily as much as $25 per horsepower year in favor of water power. That amount on one-third of the water power in the United States, capitalized at 4 per cent, can be expressed only in terms of billions. It is not necessary to go into details, but data regarding one in particular of the great powers here is interesting.

Government engineers reported an average flow in the Pend Oreille River, at Priest River, Idaho, dur-



Incidents in Camp Life for the Power Engineer in the Northwest.

Lower Falls in the Spokane River. This Gigantic Power Is Located in the Heart of the Business District of Spokane, Washington.

ing the year 1904 of 28,130 second-feet. This is a very steady stream, the ratio of its maximum to its minimum flow in that year being 12 to 1. Compare that with a few Eastern streams: The Hudson at Mechanicville, N. Y., 80 to 1; the Susquehanna at Harrisburg, Pa., 49 to 1; the James at Buchanan, Pa., 76 to 1; Yadkin at Salisbury, N. C., 51 to 1; the Tennessee at Knoxville, Tenn., 57 to 1; the Merrimac at Garvin Falls, N. H., 30 to 1; the Potomac at Point of Rocks, Md., 168 to 1.

There are three lakes, Flathead, Pend Oreille and Priest, having a possible storage capacity sufficient to maintain a constant flow during the low water months equal to half the average for the year. The drop of the stream between Lake Pend Oreille and the Columbia is 750 feet, mostly within a small part of its course. It will be safe to assume an available fall of 5/6 of the whole fall, that is, 625 feet. The result of a useful effect of 80 per cent of the theoretical horsepower would be the enormous amount of 800,000. The significance of such a water power will be more readily realized by the following comparisons: By the terms of a treaty with Canada only 20,000 second cubic feet of water can be taken from the Niagara River at the falls on the American side. The fall is about one-third as much as the estimated available fall of the Pend Oreille, so the result will be 400,000 horsepower.

A few comparisons of average volume of water power streams will be instructive. The ratio of the average volume of the Pend Oreille to the stream named below is as follows: To the Hudson at Mechanicville, N. Y., 3 to 1; to the Tennessee at Knoxville, Tenn., 2 to 1; to the Colorado at Yuma, Arizona, 2 to 1; to the Missouri at Townsend, Mont., 4.7 to 1; to the Susquehanna (West branch) at Williamsport, Pa., 3 to 1; so the Pend Oreille stands easily at the head of the water power streams of the United States in the matter of commercially available power. When the time comes—as it will sometime, though far in the future in the case of a power so tremendous—that this power is all utilized, the saving of the difference between the cost of this power and steam power will amount to $20,000,000 a year. Besides, the Pend Oreille there

General Topography and Scenic Effects Encountered in Gathering Data on Drainage Areas in High Mountains of the Inland Empire.

are many large water power streams in the Inland Empire. Large drop in a comparatively short distance after the stream has attained to nearly its full size is a feature here. The drop in the Spokane river between Lake Coeur d'Alene and the Columbia is 1224 feet, and in the Kootenai between Lake Kootenai and the Columbia about 400 feet.

I once made a table illustrating a combination of the Chelan and Spokane powers—the 132 feet fall at Spokane Falls—to give both the benefit of Lake Chelan as a reservoir, by harnessing the two into one electrical system. By using all the water at both

Sheep Creep Falls, North of Spokane.

places in 1904 the combination would have yielded 183,470 horsepower. In this plan the Spokane power is supposed to be equipped up to 170,000 horsepower, and when the stream has that capacity hold the water at Chelan in the lake reservoir. When the capacity of the Spokane falls below 170,000 horsepower, bring the Chelan power in for enough to make up the deficiency. In September of that year Spokane would have been supplying 19,404 horsepower and Chelan 150,596 horsepower. In October the amounts would have been 16,428 and 153,572; in November 16,608 and 153,392, and in December 21,228 and 148,772 horsepower.

I doubt whether there is another water power in the United States out of which so much could be made, according to volume and fall, as out of the Chelan power in such a combination. Lake Chelan has sufficient capacity, by cutting a channel at the outlet to draw the water down, to render this plan feasible. It can easily be given the capacity of the Roosevelt reservoir in Arizona, which cost $7,000,000 or $8,000,000. Water power is a perpetual resource, as streams run on forever, whereas coal mines and oil wells, sources of energy, sooner or later become exhausted.

FOR OIL BURNING LOCOMOTIVES, SACRAMENTO DIVISION, SOUTHERN PACIFIC CO.

"Data" for September contains the following interesting statistics relative to oil burning on the Sacramento Division of the Southern Pacific Company's lines:

Class of engine	10 wheel	Consolidation	Mallet consolidation.
Service	Passenger	Freight	Freight
Date of test	May, '08	June, '09	Nov. '09
No. single trips	2	2	2
Time of test	17hr. 39m.	21hr. 23m.	29hr. 2m.
Runnng time	13hr. 55m.	12hr. 59m.	18hr. 11m.
Miles run	315	174	174
Av. st'm pres.	196.0	196.1	194.5
Smoke box tem F.	797	738.5	451.3
Water evap., gal.	44147	48103	91087
Water evap., lb.	367642	400858	759058
Oil burned, gal	3951.6	4328.4	7692.1
Oil burned, lb.	31613	34627	61537
Evap'n lb water per lb. oil	14.11	13.95	15.04
Lb. water evap per sq. ft. heat. surf. per hr.	8.698	8.809	6.392
Lb. oil burned per sq. ft heat. surf.			
No. cars in train	7	14.5	24.5
Weight train tons	342	481	1056
Gross ton mileage	107730	83694	183744
Water evap. per 1000 ton mi., per hr.	0.748	0.761	0.518
gal	409.79	574.75	495.73
Water evap. per 1000 ton mi., lbs.	3413	4790	4131
Fuel oil burned per 1000 ton mi., lbs.	34.90	48.40	39.51
Fuel oil burned per 1000 ton mi., lbs.	279.20	387.20	316.08
Boiler efficiency, %	73.84	72.83	78.52
Max. i. h.p.	1719	1470	2486
Mean i. h.p.	1368	1222	2057
Engine No.	231	2564	4001
Size cyls., in.	22x28	22x30	26 & 40x30
Diam. of drivers, in.	63	57	57
Wt. locomotive lb.	203300	208000	425900
Wt. on drivers, lb.	160000	187000	394150
Wt. of tender, lb.	138070	134745	169765
Heating surf., sq. ft.	2994	3403	6394
Feed water heater, ht. surf., sq. ft.	......	......	1221

SAN FRANCISCO BRANCH OF A. I. E. E.

On September 29th the San Francisco Branch of the American Institute of Electrical Engineers held their regular monthly meeting at the Home Telephone Building. The topic for discussion was on Public Service Commissions. Max Thelan, attorney for the California Commission, was introduced as the speaker of the evening by Chairman S. B. Charters. The following were Mr. Thelan's interesting remarks as taken from the stenographic report:

PUBLIC SERVICE COMMISSIONS.

BY MAX THELAN.

I shall proceed to make a few introductory remarks as to the history of the movement in this country; after having done that, take some representative commission—possibly the Wisconsin Commission—and show somewhat in detail just how that commission does its work; then suggest a few of the most interesting problems in connection with this regulation of public service corporations, and then possibly at the end say a few words concerning what it is proposed now to do in the State of California.

The regulation of public service corporations first took the form of regulation of railroads—and generally of steam railroads; and we find that the first act conferring any power of State control over a public service corporation in this country was an act passed by the General Court or Legislature of Massachusetts in the year 1864. The effective control, however, under that act did not begin until the year 1869, when the Railroad Commission of Massachusetts started its splendid work under the chairmanship of Charles Francis Adams. The Massachusetts commission did not have the authority to fix rates—it simply had power to recommend. During all these years up to the spring of this year the Massachusetts Commission could not fix a rate; but while I was in Massachusetts this summer the General Court, in response to the wishes of Governor Foss, finally conferred upon their railroad commission the authority to fix rates. It was here in California in 1879 that a State Commission was first given the power to fix a rate for a public service corporation; and the public service corporations which were affected here, as the constitution then stood and now stands, are railroads and other transportation companies, but none of the so-called public utilities. Texas followed suit the next year in 1880; and since then almost all the States of the Union have erected some State authority which has control over the rates and generally over the service of at least railroads, and in many cases of other public service corporations. There are only three States in the Union that do not have this kind of control. One of them is Delaware (I suppose that is too small to do anything); another is Utah—which is too firmly controlled by corporations—and the third is Idaho; but in every other State in the Union we have some State authority which can regulate and control the railroad corporations of the State.

Now about public utilities. A distinction is often made between other public service corporations and public utilities, which are considered to include telegraph and telephone companies, gas, light, heat and power companies and water companies. Massachusetts took the first step in this regard also, but it wasn't until 1885. In that year the Gas and Electric Commission of Massachusetts was created. That commission did have power of its own initiative to fix a rate, but did not have power, in case a complaint was made, to investigate the complaint and then to fix the rate. It also has control over stocks and bonds, over service and most kinds of control that any of the State Commissions have today. Although Massachusetts started this control over public utilities in 1885, practically nothing was done by any of the other States until 1907. In that year three of the leading States adopted statutes providing for State control of public utilities. Oklahoma did so in her constitutional convention, New York by statute in response to the message of Governor Hughes, and Wisconsin also by statute in response to the message and the instigation of Governor La Follette. Next year Vermont followed suit, and then Maryland in 1910, and finally, in the spring of this year, we find the legislatures of quite a number of the States passing public utility statutes, giving to a State body—either the Railroad Commission or a Public Service Commission—a control over public utilities analagous to that which was being exercised over railroads.

To show you how general this movement is over the country, I shall mention in passing some of the different States whose legislatures have this year adopted such statutes: New Hampshire and New Jersey in the East; Ohio and Kansas in the Middle West; and Washington, Oregon and Nevada in the extreme West; and the matter is being considered in Colorado, Iowa and other States. I think it must be apparent now that this movement for some kind of regulation and control of the public service corporations of the country is very widespread. It is not confined to any one locality or any one kind of State. We find Massachusetts, the most conservative of all the States of the Union, leading in it, and Nevada, one of the most radical, coming in line today. We find New York, one of the richest States, if not the richest State in the Union, having what is one of the very best public service commissions of the country; and we find that Wisconsin, which is generally regarded as a progressive State, doing probably the very best work of all.

Now a word as to the actual form that these statutes take, and particularly those which I have last referred to, those which were enacted this year, and those enacted in 1907 in Oklahoma, New York, Wisconsin.

Those statutes generally provide that a State Commission shall have power to regulate and control all kinds of public service corporations—not merely railroads but public utilities as well. The statutes generally provide that these bodies shall have the power to fix a rate; that they shall have the power to control service and facilities; that they shall have power to control the issue of stocks and bonds, and some of them provide that the State Commission must first give its consent before any utility or public service corporation can start operations. This last feature has been worked out in its most complete form in the State of Wisconsin in what is known as the indeterminate permit. An indeterminate permit is simply a provision to the effect that if a public utility of a certain kind, such as a gas plant, is operating within a municipality, and has consented that its franchise become indeterminate, then no other utility of the same kind, that is, no second gas plant, can come in unless the State Commission certifies that public convenience and necessity (that is where we get the term "Certificates of public convenience and necessity"), require that the second company shall come into the

field. The object of such provision is two-fold. In the first place, it is to prevent ctt-throat competition, where there is no sense and no need for it. In the second place there is a further provision in connection with the indeterminate franchise, and that is this, that in return for those privileges which are granted to the corporations that are already in the field they must consent that the municipalities may purchase them at a fair price. Now that is fair to the cities and it is fair to the companies as well. That, I think is the most advanced step that has been taken yet by any of the States in the regulation and control of public service corporations, and it is one that the corporations themselves are very largely in favor of; and we find the opposition to this provision not so largely from the public service corporations as irom people of ultra-radical views, who want all the competition they possibly can have, even if it is cut-throat competition, thinking that the public will ultimately be best served in that way.

There are some problems in connection with public service corporation control which are of very great interest; and I find that very few, if any, of the State Commissions of the country have reached a solution of these problems which is satisfactory to them or to anybody else. One of the most important of these problems is the questions of what shall be the basis for fixing a rate? Assuming that you have a State Commission which has authority to fix a rate, on what property shall that corporation be given a return? Now we have had many bases suggested. It has been suggested that the original cost of the property plus additions and improvements should be the basis. Again, it has been suggested that the present cost of reproducing the property should be the basis. Again, it has been suggested that the present cost of reproducing the propery less the depreciation should be the basis. Again, it has been suggested that the stocks and bonds should be the basis. Again, it has been suggested that in determining the basis we must consider not only all these elements, but also such elements as give to a corporation a peculiar going concern value. For instance, with a railroad the density of population through which a railroad moves is an important element, and also the possibility of doing business because of its particular location, as against another railroad which may have cost exactly the same amount of money, but which may be located in a community which does not have many resources, so that its opportunities for earning profits are less. These questions have assumed particular importance because of the decisions which have recently been rendered in some railroad rate cases, and particularly the decision of Judge Sanborn in Minnesota. Judge Sanborn, in the Minnesota rate case, used as a basis the cost of reproduction of the property today. He considered nothing else and he made a finding which found that cost to be about 50 per cent in excess of anything that the testimony showed. I do not state this on my own authority, but I state it on the authority of the Commission of Wisconsin and the Commissions of other States who have looked very carefully into the matter; and naturally the Commissions throughout the Middle West are very much exercised over this decision. The case will be argued in the United States Supreme Court this October; and I feel that a great many of these questions as to what is the proper basis for fixing a rate will be settled by the Supreme Court before the year is over; so that, as to those particular questions we need not have the same difficulty that we have had in the past.

But there are other questions also which are of very much importance, to engineers I think particularly. One of the questions is, how are you going to ascertain the amount of depreciation which is to be charged to operating expenses each year. Very little attention has been given to that question by any of the commissions. Take your other question of depreciation. Suppose you are trying to find the value of the plant, and suppose you take as a basis the cost of reproduction less depreciation, just how are you going to determine that depreciation in ascertaining the value of the plant? I feel a little hesitancy in discussing these questions here, because they are all new in this State, and everyone of them will have to be decided by the present railroad commission, and naturally I do not wish to prejudge the case either for the Commission or myself; and all I can do at present is to indicate some of these interesting problems, and we must trust that this Commission will go at them with intelligence and with thoroughness, and in view of all the light it can get both in this State and other States, so as to try and reach a conclusion which will be intelligent and which will be fair.

There is just one other matter about which I wish to speak, and that is the problem in California.

I think that we are all probably very much interested in how our public utilities are to be controlled in this State; and in dealing with that problem I had better say a word first as to the conditions as they have existed in this State in the past, and then secondly, as to the changes which it is now proposed to make.

It is needless for me in an audience of this kind to say very much about the nature of control which our cities and counties have exercised in the past. You are just as familiar with that doubtless, or more so, than I am. We all know that the cities have had the power to fix the rates of public utility corporations within their boundaries, and that they have had certain police powers, but that, outside of these powers, they had no powers as to service or facilities, unless the franchise which the corporation received from the city specified that such powers might be exercised. For instance, there is no power in a city to force the extension of a gas main unless the gas company, in securing its franchise, should have consented that this power be reserved. No city has had the power to control a stock or bond issue, even of a utility that is entirely within its borders. So much for city control.

As to county control, if I am correct, that control has been exercised chiefly with regard to water companies. The constitution makes it the duty of boards of supervisors to fix water rates, but I am not aware of this power having been exercised as to other utilities.

As to State control, up to the present the State

Board of Railroad Commissioners has been the only State authority which has exercised control over public service corporations other than, of course, our taxing authority. Now this Board has had control simply of railroads and other transportation companies; and in the Market Street Railway case our Supreme Court has decided that this did not include the street railroads; so that the Board has had control over railroad companies, express companies and steamship lines—that is, those steamship lines that did not operate on the ocean. The kind of control that the State Board has had has been two-fold: the power to fix a rate, and the power to establish a uniform system of accounting; that is all—just those two powers. By mentioning those two powers, the constitution by implication has prevented the exercise of any other power; so that, as the constitution stands today it is not possible for the State Board to regulate any question of service or facilities of a railroad company, or to make any order in the matter of the control of stocks and bonds.

What the commission has done these last thirty years seems to have been largely to draw its salary. I understand they were rather regular in this; and I cannot refrain at this point from telling a little incident which happened to me in the State of Washington this summer, and which I have told on several occasions lately on the stump. I went North and East and South this summer to examine the work of the best railroad and public service commissions, in the hope that our Commission here might be guided by the best thought of those men in solving these same problems; and I found in Washington a very brainy lawyer by the name of Fairchild, who is the Chairman of the Washington Public Service Commission. About four years ago, Washington woke up and established a public service commission. Mr. Fairchild came down here to San Francisco in order to learn how railroads were regulated. He had the Constitution of California; knew that we had a Railroad Commission since 1879, and assumed that in the 30 years and over which had passed since then this State must have accomplished great results in the way of the regulation of railroads and other transportation companies. So he came here to San Francisco, and went into the office of the Railroad Commission, and found there one individual, a pretty stenographer, he told me—in fact he said she was very pretty—and he asked her where the Commissioners were. She said she was very sorry, but they were out; so he went away, and in the afternoon he came back again, and repeated his inquiry as to where the Railroad Commissioners were, and the girl hesitated a little while. "Well," she said, "they are out." And he said, "I am Mr. Fairchild. I am from Washington. We have a new public service commission up there, and want to find out how you people have been regulating railroads during the last 30 years." "Well," she said, "I am very sorry, but the commissioners never show up except at the end of the month, when they draw their salaries."

Mr. Fairchild, however, is a persevering sort of a man; he usually gets what he wants; and he thought he would hunt up the Secretary of the Commission, and he finally found him, and he said, "Mr. Secretary, I have come all the way from Washington to find out how to regulate railroads, and I haven's had very good success so far. Now, can't you tell me?" The secretary said, "That is easy enough. All you have to do is to make the people think that everything is all right, and that is all there is to it."

Now that is the way that our railroads have been regulated in this State for the last thirty years. We have absolutely nothing to guide us here by what has been done in California in the past. Those thirty years have been wasted. The people have paid from one hundred and twenty to one hundred and fifty thousand dollars to the Commissioners in those years, and have got nothing for it. What is to be done now? In the first place, the last legislature passed what is known as the Eshleman-Stetson railroad bill. That is a good bill as far as it goes, but at every step the legislature found itself hampered by the provisions of the present constitution. The legislature did the best it could in working out the powers given by the constitution; but the conclusion was borne in upon them—as it must be upon all thinking men in the State—that if we are to follow in the footsteps of the most progressive States in the Union the constitution must be changed, so that our Commission may exercise the powers which are exercised by the Commissions in these other States; and for that reason three constitutional amendments were proposed. I am not going into the details of those amendments unless there should be an inclination later on to learn more of them, except I will state simply in a word or two what each of the three amendments proposes.

First is Assembly Amendment No. 50. That is a simple amendment, and refers simply to the power of the Commission over the rates of railroad companies, and removes certain limitations in the constitution at present. For instance, at present the railroad commission has no power over commutation rates. We can do nothing there. At present there is a long and short haul clause in the constitution which is absolutely rigid—no exception at all. It has never been obeyed, but here comes the present commission which has to obey the law, which intends to obey the law, and it finds what is called the long and short haul clause, which makes it unlawful for a railroad to make a rate for a longer distance lower than for a shorter one in the same direction and over the same route, absolutely, independently of what the conditions may be, even if there is water competition forcing a lower rate for the longer distance than the shorter one. But there stands the constitution. It must be changed, or else the entire railroad system of the State must be revolutionized. What is now proposed is to read into the constitution the same kind of long and short haul clause which is in the Interstate Commerce Law. The clause is there, but power is given to the commission, when conditions justify it, to deviate from it—a sensible conclusion.

There is another innovation in Assembly Amendment No. 50, which gives to a shipper, in case of an excessive or discriminatory rate, the right to appear before the commission instead of having to go through the process of a suit in court.

The next amendment is Assembly No. 6, which

increases the number of commissioners from three to five, because of the extra work which will result from the control over public utilities. It provides also for appointment by the Governor instead of by election by the people. All the commissions of the country which are doing the best work are those that are appointed instead of elected. I found that in New York, Wisconsin, Massachusetts, Washington, and in practically all of the States which have recently adopted railroad or public service commission statutes the commissioners are appointed. The reason is very obvious, because you are much more likely to get trained men and experts on a commission of this kind by appointment than by election. By election you are likely to get three farmers, or three lawyers, or three business men, or three men of leisure as we have had in the past; but by appointment you may get one lawyer versed in railroad law; one man who is versed in accounts and statistics, and one who is versed in practical rate making, as is the case in Wisconsin; or you are likely to get one lawyer who understands railroad law, one man versed in finances, so he can handle the stocks and bonds, and another versed in the practical operation of railroads, as is the case in Massachusetts.

So I think there is no doubt at all that this is a provision in the way of a more intelligent and able board than we have had in the past. But the most important provision in this No. 6 is the one which provides that the legislature can confer upon the State Commission additional powers. This is necessary because of what I pointed out to you, that the constitution at present gives the Commission only the power to fix a rate, and the power to prescribe a uniform system of accounting; so that, in order to secure a regulatory control over the issues of stocks and bonds, and over service and facilities, it is absolutely necessary that these provisions be added. I do not know whether the gentlemen here are very generally in favor of control over stocks and bonds; it may be that some of you are not. Possibly your natural interests would be opposed to that; but the experience of the States of the Union seems to show that that it absolutely necessary, and the great mass of the people, there is no question, are heartily in favor of it. No honest corporation need fear this, but the wild-cat corporations fear it, and ought to.

In New York City I found every street railroad is in the hands of the receiver. I tried to find out why, and they told me this: That originally there were a large number of street railroads in the City of New York, and these began to consolidate, two here, three there, and so on; and every time they consolidated they watered the stock and issued an amount of bonds which was in excess of what they had before, with the result that the street railroads today have a large amount of water in the stock and an excessive bond issue, which makes it impossible for them to pay the interest on the outstanding securities. The result is that the people can't get new cars or equipment. There is one eternal fight between the Public Service Commission of the First District and the street railroads, because the Commission is trying to undo to some extent what has been done, and can't make any headway, and the corporations are trying to keep what they have got, and in the meantime the public suffers. I do not think that any public service corporation that sees the tendency of the times can object to a control over stocks and bonds which is exercised by an efficient commission. The honest corporation has nothing to fear, but the wild-cat corporation has, and it ought to; and I am willing to do my part to make the wild-cat corporation fear that sort of thing. That is about all there is to No. 6.

Now the other amendment—which I think is possibly of more interest to you gentlemen than any other—is Senate No. 47. That is the amendment which defines public utilities, and which gives to the State Commission certain kinds of control over certain of those public utilities. Public utilities are defined to include all kinds of railroads, adding street railroads to the present railroads under the control of the Commission; and in addition to those, telegraph and telephone companies, gas, heat and power companies, water companies, canal, pipe-line companies, wharfingers and warehousemen. The amendment provides in the first place that the Commission is not to exercise control over those plants if owned by municipalities. Those municipalities are to continue their regulation in their own way for their own utilities, that is, those which are publicly owned. It provides also that the municipalities are to keep the present powers which they have over privately owned utilities, unless the people, at an election called for that purpose, confer these powers upon the State Commission.

Now this particular provision has been subject to quite a little criticism, and in my opinion it is not the last step in the matter. I think that, possibly with the exception of some of the very largest cities, such as Los Angeles and San Francisco, it would be wiser if the State had the entire control, including the power to fix a rate. The reason for the submission of the amendment in its present form is simply this: Los Angeles has a Public Service Commission of which it is very proud. There is a strong local pride in the city of Los Angeles, and even if they kick out three incumbents now, and three then, and three more some other time, they would never consent, at least for the present, that such power as they have won be taken from them—so that if this amendment had been submitted in the form suggested by some of the men who are affiliated with the public service corporations of this city, namely, that the State should take over the whole power, it would have been defeated. Now the question which confronts us here is simply this, as to whether it would be wiser to submit an amendment which would be defeated, or what amounts to the same thing—defeat the present amendment—or to pass the present amendment. Now to answer that question I think it necessary that we find out just what changes in the existing order of things this amendment will create. In the first place, let me illustrate what I want to say with a rough diagram. Suppose we take this blackboard as representing all the powers of regulation and control which can be exercised by any authority in the State. Now suppose that this triangle in one corner represents

the powers which are at present possessed by the municipalities of the State. Those powers are simply, first, to fix a rate; and secondly, to enact certain police ordinances, such as the power to force a street railroad to put on car-fenders. Those are the only powers that are exercised by any municipality today as to public utilities. Now there is a great residuum in the State. First, there are corporations not subject to any control today, such as the telegraph companies, the power companies, and the pipe-line companies. Those corporations are not subject to any regulatory power today; and if the principle of public regulation is good, it would seem that we should consider very seriously the question of whether we should defeat the amendment, and in that way deprive the public of any kind of regulation and control over these particular corporations. In addition to the corporations I have mentioned, there are telephone companies outside of cities and gas and electric light companies outside of cities. I do not understand that these companies are today subject to public regulation, and as to those companies the entire field of regulatory power—the control of rates, stocks and bonds, extensions and so forth, is open. In addition to that, with reference to the corporations down here (indicating the triangle) which are regulated only in part today by the cities, there is a certain scope of authority which even the cities do not exercise—for instance, the control over stocks and bonds. If this amendment passes, the entire residuum of power here, which is today exercised by nobody as to certain corporations, and which is exercised today by the cities only in part as to other corporations, will be conferred upon the State authority. It seems to me it would be far wiser to take what is offered to us now, although it may not be perfect, and then work out the remaining portion of the problem later. Just to take a homely illustration, I think it is better to take the three-quarters of the loaf that is offered to us today rather than take no loaf at all. We have no assurance that any future legislature within a reasonable time would submit the kind of amendment which some of you gentlemen possibly think ought to be submitted; and if it were submitted we have no assurance that it would not be defeated by a combination between Los Angeles and San Francisco. So I think that most of us who really thoroughly believe in the principle of public regulation and control will be in favor of this amendment, although it has defects. I say that frankly. It has defects, but I think its defects are insignificant as compared with its advantages.

That is about all that I had to say. These problems are extremely difficult, and they are problems which call for co-operation. The State Commission will, of course, go ahead, even if it does not get any help from any of the public service corporations. From what I know of the State Commission today, it will go ahead to perform its duty. It owes a duty to the public and to the corporations also, and it will perform that duty; but it can perform it far more wisely and efficiently if it has the co-operation of the men who represent the public service corporations of the State; and I feel from what many of them have told us that we will have the hearty co-operation of at least most of the corporations. I hope that we may attain the same results which have been attained in Wisconsin. In Wisconsin the public service corporations are now very strongly in favor of the State Commission. Of course that is partly because of the splendid, thorough, scholarly work which that Commission has done—a work which has resulted very largely from its association with the University of Wisconsin. Graduates of the State University bring to the Commission a scholarliness and thoroughness and an unprejudiced view which have resulted very largely in the efficient work of the Commission. I should like to see that same kind of work done here in this State, and I think it will be, and I hope that in that work we may have the help of the public service corporations themselves.

IRON LOSS IN THE CURRENT TRANSFORMER

Some interesting conclusions have been recently reached by the Bureau of Standards in a series of tests performed in a study of the current transformer with particular reference to the so-called iron loss. The conclusions are nine in number and are as follows:

1. While the ratio of transformation of current transformers usually decreases with increasing current, it may increase in individual cases, or even pass through a maximum.

2. The ratio and the phase angle performance may be accurately computed from the magnetic data of the core.

3. In general the slope of the ratio curve may be qualitatively predicted from the value of the Steinmetz exponent if the latter be assumed to be constant. But the iron losses, particularly at the low flux densities used, depart too widely from such a simple law for accurate work.

4. The slope of the ratio curve may be accurately computed from the slope of the curve obtained by plotting the core loss against the flux on logarithmic coordinate paper.

5. It is proposed that this logarithmic slope, or logarithmic derivative shall be called the ratio of variation. It is much more useful than the actual exponent.

6. The methods now in use for determining the "exponent" fail to give a true exponent that will satisfy the equation $W = KB^n$ unless n is a constant. The quantity actually determined by these methods is the ratio of variation.

7. The wave form of the secondary of a current transformer may be considered to be the same as that of the primary current [illegible] the most precise measurements, as [illegible] the transformer is entirely negligible.

8. While the effect of variations in wave form on ratio and phase angle may be detected by accurate measurements, it is too small to be of practical importance, being of the same order of magnitude as the effect of small changes in frequency.

9. The method now used for accurate determinations of ratio and phase angle will give the theoretically correct results well within the experimental errors, so that the accuracy attainable is decidedly greater than is required in practice.

R7LATION BETWEEN WEIGHT AND OUTPUT OF INDUSTRIAL MOTORS.[1]

Part II.

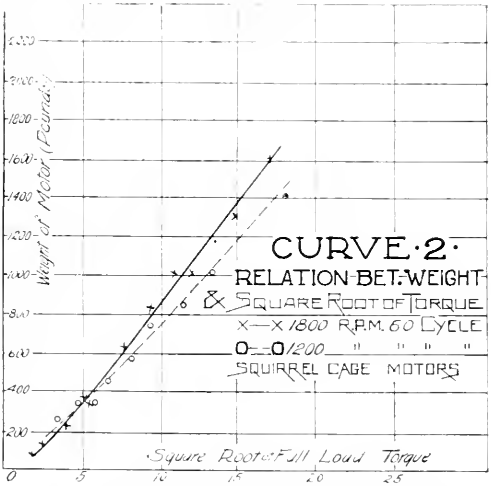
Induction Motors.

The weights given in the accompanying tables are commercially called "Frame Weights." Two machines built on the same frame will have the same frame weight. For instance, the 5 and 7½ h.p. eight-pole motors are built upon the same frame and hence are given the same weight commercially, although the actual weight of the 7½ h.p. motor would be somewhat more, and the actual weight of 5 h.p. motor somewhat less than the value given in the table. This fact causes the irregularities shown on the curves. The square roots of the torque are figured from the torque obtained by using full load horsepower and synchronous speed. The latter is used for convenience.

TABLE 3. SQUIRREL CAGE INDUCTION MOTORS, 60 CYCLE, 110, 220 AND 440 VOLTS.

RATINGS AND WEIGHTS.

	4 Pole.		6 Pole.		8 Pole		10 Pole		12 Pole	
1	17.1	75	....	....	....	...	....	...	....	...
2	2.42	120	2.94	170	....	...	....	...	....	...
3	2.94	170	3.48	230	....	...	....	...	....	...
5	3.86	230	4.68	345	5.4	470	6.04	580	6.62	740
7½	4.68	340	5.73	345	6.62	470	7.40	580	8.1	740
10	5.4	340	6.62	470	7.65	580	8.55	740	9.36	860
15	6.62	513	8.1	580	9.36	740	10.40	860	11.4	1135
20	7.65	634	9.36	740	10.8	740	12.1	860	13.2	1135
30	9.35	834	11.4	860	13.2	860	14.8	1135	16.2	1415
40	10.8	1013	13.2	1013	15.3	1135	17.1	1135	18.7	1415
50	12.1	1013	14.8	1307	17.1	1415	19.3	1415	20.9	1870
75	14.8	1307	18.1	1415	....	....	....	....	....	....
100	17.1	1611	20.9	2211	....	....	....	....	....	....

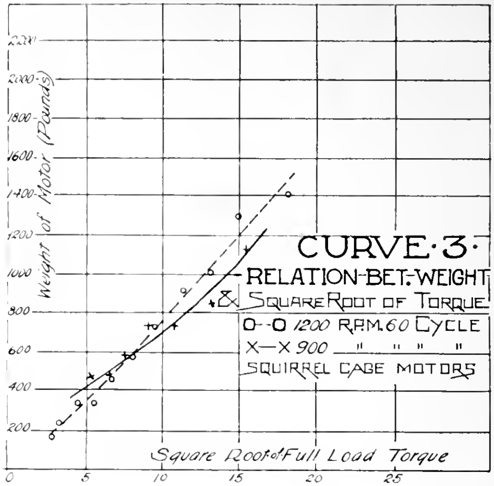


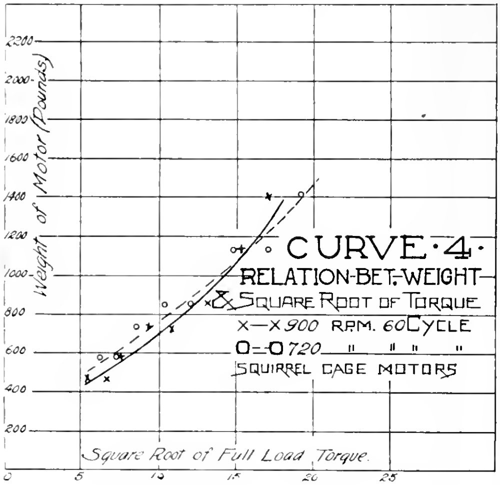
Curve 2 shows the relation of the weights of 4 pole and 6 pole motors to square roots of torques. At the lower ratings 4 pole motors are lighter for same torque than the 6 pole motors, but are heavier on ratings above square root of torque equal to 6.

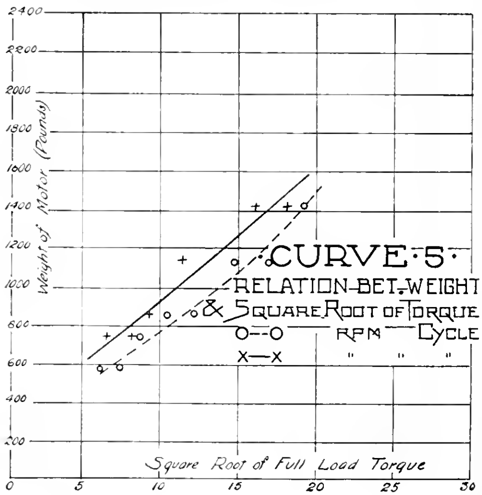
Curve 3 shows relation weights of 6 and 8 pole 60 cycle induction motors. Note that above square root of torque equal to 8, the 8 pole motors are lighter for same torque than 6 pole motors.

Curve 4 shows that curves representing weights of 8 and 10 pole motors cross at value of square root of torque equal to 15.5.

[1] Continued from issue of October 14, 1911.







Curve 5 shows that within range of ratings given the 12 pole motors are heavier than the 10 pole motors for the same torque. The curves if plotted out to larger ratings will cross at point where the 12 pole motor becomes lighter than the 10 pole motor for the same torque.

The above method of lining up weights afford a convenient method of lining up weights of different types of machines and also shows if any discrepancy occurs in weights of particular machines.

PRIMER OF APPLIED THERMODYNAMICS.[1]
EIGHTH LECTURE.

Feed Water Heaters, Condensers and Injectors.

Although the study of Thermodynamics may be interesting to the student of mathematics simply as a combination of playful symbols enabling him to enjoy that exquisite pleasure known only to those who have entered the inner threshold of this wonderful branch of reasoning, it would never be interesting to the practical engineer could he not apply the fruits of his study to the advancement of the profession.

Having now acquired a ground work upon which to build applications of Thermodynamics we shall find it exceedingly interesting to look into some of the fundamental accessories of the modern power plant.

We have previously seen that an enormous amount of latent heat energy is absorbed in the evaporating of water into steam. When this steam, after use in the engine cylinder is exhausted into the air a large quantity of energy is lost by being put to no useful purpose. It is evident, then, if the exhaust steam could be condensed into water by bringing it in contact with cold water, the cold water would easily absorb the latent heat in the steam, thereby causing the temperature of the cold water to be materially increased. Now if the particular cold water used is that of the feed-water for the boiler, a considerable saving in heat energy is thereby effected, for one B.t.u. is saved for every pound of water raised one degree. A contrivance accompanying this result is known as a feed-water heater. When the steam is brought directly in contact with the water, the heater is said to be of the open type, and when the heat from the steam is absorbed through an intervening medium, it is said to be of the closed type. A typical example of feed-water heaters is the so-called Cochrane Feed-water Heater shown in Fig. 18. This device not only heats the entering water by means of the exhaust steam, but by means of the clever accessories shown in the illustration, the oil which is contained in the exhaust steam is deposited at the oil separator shown in the diagram. The cold feed-water enters from above on the slanting plates as shown and, in trickling down over them, comes in intimate contact with the steam after it has passed the oil separator. Coke is placed in the bottom of the heater, and, as all the water must pass down through this, the water is thereby largely purged of all impurities, and thus assistance is given for maintaining more perfect boiler operation.

[1]A resume', devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

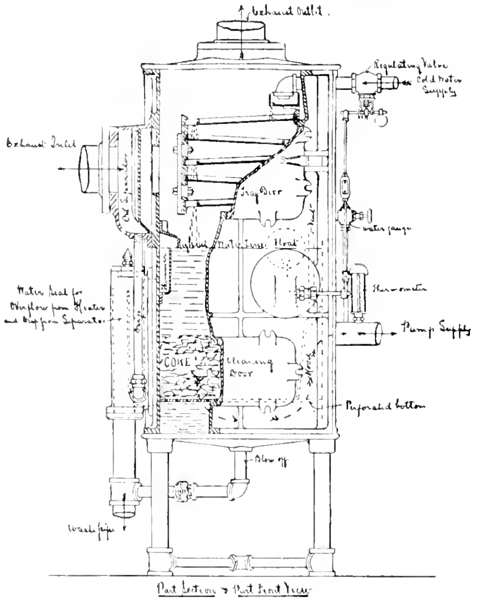


Fig. 18. Cochrane Feed-water Heater.

The Wainwright even-flow surface condenser as shown in Fig. 19 is a good illustration of surface condensers and also illustrate the closed type of feed-water heater. The steam is exhausted into the main drum as shown, and water circulates through copper tubes traversing this drum. These tubes are held in the tube plates without any soft packing or screw glands, but by the use of hard brass thimbles tightly driven. The grouping of the tubes sends the circulating water at least four times through the condenser chamber.

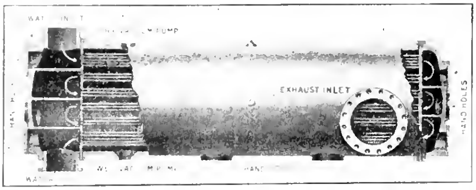


Fig. 19. Wainwright Surface Condenser.

It is evident, then, that the feed-water heater serves a double purpose; for, if properly installed, the water going into the boiler is not only heated, but by condenisng the exhaust steam it increases the mean effective pressure of the steam in the engine cylinder. Operating under these conditions our engine is said to be condensing. Pressures below that of the atmosphere are thereby used.

In ocean-going vessels the so-called surface condenser is used almost entirely, for the salt water pumped in from without must not be allowed to go directly into the boilers as it is very detrimental. On the other hand, for stationary engines on land, the jet condenser in which the cool water mingles directly

with the steam, thereby condensing it, is found often most economical. In considering the heat quantities, the same mathematical formulas can be used for the computations in feed-water heaters as in condensers. The only thing to be careful of is to remember that in the open feed-water heater and the jet condenser, the condensed steam becomes equal to the heated water, while in the closed feed-water heater and the surface condenser, the water after being condensed from the steam is usually not lowered appreciably below the temperature of saturated steam for the pressure under consideration.

In order to be able to compute the quantity of water that will be heated a given number of degrees by the heat from the steam in either the closed or open type of feed-water heater, once again we appeal to our elementary Thermodynamic considerations. Thus, the heat surrendered by the steam will be equal to the heat gained by the water, neglecting minor losses due to radiation and the like. This is best seen by an illustrative example. An engine discharges 8000 lb. of steam 0.95 dry per hr. at atmospheric pressure. How many lb. of water per hr. can be raised from 60° F. to 200° F.. Each lb. of steam mixture has as latent heat 0.95×970.4 B.t.u. There is represented in each lb. of steam mixture a liquid heat of 180 B.t.u. also. In the open type the condensed steam will become equal to the feed-water temperature, or 200° F.

Hence in 8000 lb. we have, letting x be the number of lb. of water heated

$$(0.95 \times 970.4 + 180)\ 8000 = x\ (200 - 60)$$
$$-168$$
$$7{,}468{,}000 = 140\ x$$
$$\therefore x = 53{,}300 \text{ lb.}$$

In the case of the closed type, the water from the condensed steam does not cool below 212° F. Hence we have

$$(0.95 \times 970.4 + 180 - 180)\ 800 = x\ (200 - 60)$$
$$7{,}372{,}000 = 140\ x$$
$$\therefore x = 52{,}650 \text{ lb.}$$

Generally speaking, then, for the open and closed feed-water heaters and for the jet and surface condensers, we have the following formulas:

$$W\ (x_0\ L_0 + h_0 - h_c) = w\ (h_1 - h)$$

in which h_c becomes equal to h_0 when considering the closed feed-water heater or the surface condenser, and h_c becomes equal to h_1 when considering the open feed-water heater or the jet condenser, where

W = lb. per hr. of steam condensed,
w = lb. per hr. of water heated,
x_0 = quality of steam at exhaust pressure,
L_0 = latent heat at pressure of exhaust.
h_0 = heat of liquid in exhaust steam,
h_c = heat of liquid at final cooled temperature of condensed water.
h = heat of liquid in feed-water before heating,
h_1 = heat of liquid in feed-water after heating.

It is a matter of common knowledge that the pressure of water from the water mains usually installed is not sufficient to force water into a steam boiler operating under the usual conditions of installation. Hence, some device must be used that can force the water in against the boiler pressure. This is accomplished in a great many plants by means of a force pump. Under many conditions of operation especially on locomotives, a socalled injector is found most useful for this purpose.

The Penberthy automatic injector is a well-known make of this class of apparatus. Fig. 20 shows a sectional view as well as the outside appearance of this

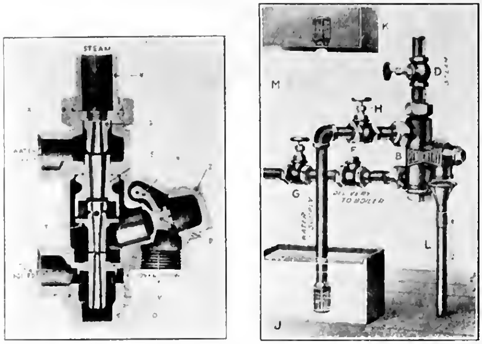


Fig. 20. Cross Section View of Penberthy Injector and View of Injector Installed.

injector, installed for operation. In this class of apparatus the steam is allowed to attain a high velocity, and, on being condensed by coming in contact with a stream of cold water, gives up part of its kinetic energy, so that the mixture enters the boiler against the pressure of the boiler. The steam to operate the injector is taken from the boiler and enters the injector at the point marked "steam" on the cross-sectional diagram, and at R begins to expand. In expanding, the steam gives up part of its heat energy, which is at once converted into kinetic energy. As the swiftly moving steam passes the opening indicated by the direction of the arrow at "water supply," a vacuum is formed and cool feed-water is drawn with the steam through S. The water almost instantly condenses the steam, and the impact of the steam greatly increases the velocity of the water. It is a well-known hydraulic principle that when water is flowing in a pipe with a given velocity, and under a given pressure, a decrease of velocity is accompanied by such an increase of pressure that the sum of the kinetic and potential energies of the water remain constant. In starting the injector, until sufficient pressure is generated to open the check valve into the boiler, the water is sent through the side opening "overflow" on the diagram. It is seen that as the water and steam mixture traverse Y, the opening gets larger and larger, which means that the velocity gets smaller and smaller. Since kinetic energy is mathematically expressed as the product of one-half the mass of a moving body by the square of its velocity, it is evident that this decreasing of the kinetic energy immediately shows itself in form of pressure or potential energy, since we know that energy, itself, is indestructible. Hence, when sufficient pressure is produced, the counter pressure of the boiler is overcome, and water allowed to enter.

Let us act upon the mechanical principles above enunciated and derive simple mathematical expressions governing the injector. Let x_0, L_0, h_0 be the state of

the steam after our usual terminology; h is the heat of the entering water and v its velocity; h_1 is the heat of the discharged water, and V its velocity; y is the pounds of water drawn into the boiler per lb. of steam used by the injector. Since the total heat of the steam is as formerly derived, $x_o L_o + h_o$ per lb., and the heat possessed by the entering water y h, as y lb. are used per lb. of steam, the total heat energy is $x_o L_o + h_o + y h$, and to this must be added the kinetic energy of the water, which is $\frac{v^2}{2g} \times \frac{1}{778}$. Hence we have the relationship

$$x_o L_o + h_o + y \left(h + \frac{v^2}{2g} \cdot \frac{1}{778}\right) =$$

$$(1 + y) \left(h_1 + \frac{V^2}{2g} \cdot \frac{1}{778}\right)$$

The right hand side of the equation above easily follows, since energy is never destroyed and since each lb. of steam now has y lb. of water, the combined mixture represents $(1 + y)$ lb. The quantity representing the square of the velocity appearing on both sides of this equation is very small compared with the other items. Hence it may for all practical purposes be entirely neglected. We then have as our equation for the injector,

$$x_0 L_0 + h_0 + y\ h = h_1 + h_1 y$$

$$y\ (h_1 - h) = x_0 L_0 + h_0 - h_1$$

$$\text{or } y = \frac{x_0 L_0 + h_0 - h_1}{h_1 - h}$$

If s is the head against which the water is forced in order to get the water into the boiler, we have for the energy absorbed (since work is the product of force and distance) a quantity equal to $s\ (1 + y)$ ft. lb. But $x_o L_o + h_o - h$ is the energy in the entering steam and water, hence the efficiency of the injector is

$$\frac{s\ (1 + y)}{x_o L_o + h_o - h}$$

In the study of mechanics we learn that the product of mass and velocity is called momentum, and that when impact takes place between two elastic bodies the sum of momentum in both bodies before and after the shock is the same. Hence the momentum of the 1 lb. of steam issuing from the nozzle added to the momentum of the y lb. of water drawn in must be equal to the momentum of the $(1 + y)$ lb. of the mixture after the impact. Therefore

Where v_1 is the velocity of the entering steam,

$$v_1 + y\ v = (1 + y)\ V$$

From this relation we are enabled to compute velocity relationships when certain quantities are given in injector design. The student will do well to examine the Thermotwisters given in this lecture and see if application of these formulas above given can easily be made.

The question of design or choice of condensing surface is usually solved by Whitham's empirical formula.

$$S = \frac{W\ L_o}{180\ (t_o - t)}$$

Where

S = square feet of condensing surface,

W = weight of steam condensed per hour,

L_o = latent heat at the temperature of exhaust steam.

t_o = temperature of exhaust steam.

t = average temperature of circulating water between inlet and outlet.

Thermotwisters.

1. Water is to be raised from 60° F. to 200° F. in a feed-water heater, the weight of water being 10 000 lb. per hour. Heat is supplied by steam at atmospheric pressure, 0.95 dry. Find the weight of steam condensed (a) in an open heater, (b) in a closed heater. Find the surface necessary in the latter.

2. Steam 0.96 dry at 130 pounds gauge pressure delivers 3250 pounds of water per hour from an injector at a temperature of 165° F., the inlet temperature of the water being 62° F. The water is measured on the inlet side of the injector. Find the weight of steam used. The velocity of the entering water is 13 ft. per second. That of the discharge is 115 ft. per sec. Find the velocity of the steam leaving the discharge nozzle. How many boiler horsepower are required or represented in the steam necessary for the injector?

Solution of Thermotwisters—Fifth Lecture.

1. Find the volume of one pound of air in an air compressor at a pressure of 100 lb. per sq. in., the temperature being 32° F., using Boyle's law only.

$$p\ v = p_0 v_0$$

Now at 32° F., v_0 for 1 lb. of air is 12.39 cu. ft. and p_0 = 14.7 lb. per sq. in. or 14.7 × 141 lb. per sq. ft. Hence substituting

$$v = \frac{p_0 v_0}{p} = \frac{14.7 \times 144 \times 12.39}{100 \times 144} = 1.82 \text{ cu ft. Ans.}$$

2. From Charles' law, find the volume of one pound of air at atmospheric pressure and 72° F.

$$v = v_0\ (1 + t/273)$$

$$72° \text{ F.} = 22.22° \text{ C. and } v_0 = 12.39 \text{ cu. ft.}$$

Hence substituting,

$$v = 12.39\ \left(1 + \frac{22.22}{273}\right) = 13.4 \text{ cu. ft. Ans.}$$

3. Find the temperature of 2 ounces of hydrogen contained in a 1-gallon flask and exerting a pressure of 10,000 lb. per sq. in

$$p\ v = R.T \qquad p = 10{,}000 \times 141 \qquad R \text{ for hydrogen} = 770$$

$$2 \text{ ounces} = 1 \text{ gallon.}$$

$$16 \text{ ounces or 1 lb.} = 8 \text{ gallons} = 1.068 \text{ cu. ft.}$$

$$\therefore T = \frac{p\ v}{R} = \frac{10{,}000 \times 141 \times 1.068}{770} = 2000.0° \text{ F. abs.}$$

$$\text{or } 2000 - 459.4 = 1540.6° \text{ F. Ans.}$$

4. How large a flask will contain 1 lb. of nitrogen at 3200 lb. pressure per sq. in. and 70° F?

$$p = 3200 \times 144 \qquad T = 459.4 + 70 = 529.4$$

$$p\ v = R\ T \qquad R \text{ for nitrogen} = 54.9$$

$$\therefore v = \frac{R\ T}{p} = \frac{54.9 \times 529.4}{3200 \times 144} = .0631 \text{ cu. ft. Ans.}$$

HYDRO-ELECTRIC ENTERPRISES IN BRAZIL.

By decree No. 8753 the Brazilian Federal Government gives a concession to engineers Francisco de Paula Ramos and Hans Hacker, representatives of commercial firms of Rio de Janeiro—Valle Rodrigues & Ramos, and Bromberg, Hacker & Co.—or to such enterprise as they shall organize for the exploitation of the hydraulic power of the Paulo Affonso Falls of the River San Francisco. The contract is for 70 years maximum, and requires a first installation of 200,000 horsepower, increased up to 1,000,000 kilowatts in 15 years after the inauguration of the first hydroelectric installation. The Sao Paulo Light & Power Company has acquired the great falls of Firambella, between Santos and Mogydas Cruzes.

WATER RIGHTS IN NORTHWEST.

BY NORWOOD W. BROCKETT.

This is probably the broadest question with which the Hydroelectric Company must deal. In the State of Oregon the matter rests with a commission operating under a water code and is principally a matter of following the statute. Broadly speaking, the riparian owner has the right to divert the water at any point upon his property for the purposes of generating electric light and power, provided he returns the water to its natural channel within the boundaries of his own land. If he does not own all the riparian rights between the point of diversion and the point of return, it is necessary that he acquire such rights, either by purchase or condemnation, from the riparian owners, as each such owner has a legal right to have the water flow by his land in the manner in which nature intended. In the absence of any appropriation or development, however, the measure of such owners' damage is limited to the financial loss which he sustains for domestic and agricultural uses and if sufficient water is left in the stream to meet such uses, his damage would be merely nominal. If an appropriation of water has been made prior to such diversion then such lower riparian owner must not only show that he intends to devote the water to a public use and the necessity therefor, but must also show that he has followed usch appropriation with reasonable diligence, preparatory to the actual use of such water.

This brings us to the consideration of the effect of notices of appropriation of water, upon which there is apparently considerable difference of opinion. In Washington and Idaho the Pacific Coast Doctrine that "the first in time shall be the first in right" controls. This does not mean that the mere posting and filing of a notice of appropriation will "hold down" a stream for an indefinite length of time, but that it must be followed with reasonable diligence in perfecting the use of the water; nor does such a notice give to the appropriator the right to divert the water from a lower riparian owner without compensating him as heretofore explained. It is, however, a notice to the world that the appropriator intends to devote so many cubic second feet of a stream's flow to a public use and all subsequent appropriators must take notice of this declaration; provided the appropriation is followed with reasonable diligence. It gives such an appropriator the right to the use of this water and prevents it from being diverted so that a diminished volume would flow through his property. As before stated, this right exists without such appropriation, but by stamping it with a public use, followed by reasonable diligence, it prevents an upper riparian owner from condemning the water from such appropriator upon the theory that one public service corporation cannot condemn property for is own use, which has already been devoted to a public use.

The right to overflow the land of another without his consent depends, of course, entirely upon the right of eminent domain. The right to overflow state land has, however, been clearly given in the State of Washington and we desire to urge upon those companies requiring storage facilities upon State lands, the necessity of perfecting such rights while this law is in operation. The statute is mandatory: it compels the State Board of Land Commissioners to grant such rights upon application and upon a showing that the land is to be used for the storage of waters for a public use. It is not necessary to purchase the property, but the damages to the State by reason of the overflow are fixed and paid and the right becomes perpetual. The question was recently raised by the State Board of Land Commissioners as to the right of a public service corporation, in damming a river, to store the waters so that they covered the banks between low water and ordinary high water, upon the theory that the State owned the banks of navigable lakes and streams up to high water mark. This contention is probably correct in so far as it affects navigable rivers. The Commission held that any river which would float a shingle bolt was a navigable river, within the meaning of the constitution. In this, however, the Commission is unquestionably wrong, as the Supreme Court has repeatedly decided that this section of the constitution means those rivers navigable for the ordinary uses of commerce and trade.

In storing water, however, by means of a dam, where the raise in the banks of the stream does not exceed or even reach the mark of ordinary high water, the riparian owner may claim damages. Such a question recently arose in the writer's company, where the rise and fall was approximately three feet a day on the claimant's property, caused by the storage of water from the company's dam. At no time was the water raised to a height which even approximated the high waters of the river, but the waters were raised to a point three feet above the mean low water in the summer. Investigation convinced the writer that the upper riparian owner was entitled to have the water flow by his property at the natural rate of flow and that any change in such flow entitled the owner to recover such damages as he had sustained. The claim for damages in this case was based upon the caving of his banks and the sub-irrigation, which caused a portion of his property lying contigous to the river to remain moist at all seasons of the year.

METHODS OF ACCOUNTING IN CONNECTION WITH NATIONAL AND STATE LEGISLATION.

BY C. N. HUGGINS.[1]

It is regretable for some reasons that external regulation of corporations engaged in supplying public service is not vested exclusively in a National Commission operating much in the same manner as the Interstate Commerce Commission, instead of such control being divided among several National, State and Municipal Commissions or Boards, each requiring some information not exacted by the others and each wishing the same results shown in a somewhat different way. Until we have some such plan of exclusive commission regulation I am afraid no general or uniform system of accounting will be found entirely adequate or satisfactory for use in different States. In the case of the Portland Railway, Light & Power Company, it must now report to the Interstate Commerce Commission, to the State Railroad Commission, to the State Tax Commission, to the City of Portland, and, of course, to the Internal Revenue Department.

[1]Treasurer Portland Railway, Light and Power Company.

Last winter a State Public Service Commission was created by the Legislature, but a referendum petition has been filed against his measure, which will not come before the people until November, 1912. In Washington the State Commission is already in legal existence, and I believe they also have a State Tax Commission, while a multiplicity of commissions exists in almost all other States.

Those of us who come under the regulation of the Interstate Commerce Commission are probably more local bodies, and our systems of accounting have because of a longer acquaintance, than with those of the local bodies, an dour systems of accounting have become pretty well standardized in the Railway Department. Likewise in the Light and Power Departments we have yielded more and more to the uniformity ecommendations of the National Association, until among the larger companies and many of the smaller ones fairly uniform methods of accounting are in vogue, although classifications of accounts seem to be somewhat at variance. This will always be the case so long as we are called upon to furnish information in more or less conflicting form. However, if we all use the methods standardized by the American Street and Interurban Railway Association and the National Electric Light Association and will subdivide our primary classifications liberally, we will find ourselves able without serious difficulty to furnish reports in almost any form demanded.

There has always been a hesitancy on the part of Public Service Companies to properly inventory and classify their property accounts, but I feel that we must now recognize the fact that we will be required to furnish sooner or later an accurate property inventory, and, if we have not already done so, we should at once take steps to prepare a very careful and fully detailed statement of all property. Such an inventory must be consistently made and records must be in such shape as to permit of ready verification.

In Oregon we are required to make report to the State Tax Commission of all property segregated among the various school, road and other taxing districts, and are supposed to show the average daily quantity of eleectricity furnished to public and private consumers in each of said districts. This is a rather difficult thing to do, and recognizing this fact, the commission has thus far waived the demand for quantities of electricity furnished. I hope they may continue to do so, but we should be prepared to furnish, at least, all reasonable information.

There has been a great change in the attitude of corporations toward public commissions during the last two or three years, and we are now appreciative of the fact that while there may be considerable annoyance in complying with the numerous demands made upon us and considerable extra expense entailed in doing so, still we have received much direct benefit from their oversight and are reaching a higher plane of stability. This is not due to any remedial action brought about from fear of investigation, but the results are obtained from several causes.

The most beneficial effort of Commission oversight has undoubtedly been due to opportunities, somewhat forcibly thrust upon us, of observing the weak points in our business methods and providing remedies therefor. Furthermore, the supervision of Governmental Commission undoubtedly acts as a stamp of approval on the reporting companies, just as much as the inspection of National Banks, the green label on the bottle of bonded whiskey or the purple stamp of the Government Meat Inspector, and the time is rapidly approaching when investors will be very chary indeed of securities of public utility companies which are not under commission regulation. This feeling is already existent and is rapidly growing.

The State Commissions will not be found unreasonable and will unquestionably co-operate with the corporations reporting to them in adopting such reasonable forms as will most readily furnish information desired with the fewest possible complications.

I understand that several of our members in the State of Washington are now working out a revised system of accounting to be submitted to the State Commission for discussion, and I think if this Association can be of any assistance in this work through a committee or otherwise, such assistance should be tendered. Furthermore, I would recommend that when such revised system is finally adopted this Association should provide itself with full information thereon, and through its Executive Committee or otherwise should endeavor to secure the adoption of the same system in Oregon and other of our Western States where Commissions are not yet in existence.

I do not wish it understood that I am in favor of absolutely uniform classification for all operating companies, as from the different local conditions affecting almost all of our member companies it is, in my opinion, entirely impossible to observe such uniformity of classifications with satisfaction to the officers and owners of the properties.

From time to time the Light and Power Associations have tried to delude themselves with the idea that perfect unifomity was essential, but I think we must all agree that such is not the case. This does not change my recommendation that the system of accounting shall be uniform, and that the methods followed in obtaining results shall be along the same general line.

In the case of my own company, some of our interests require certain information which is not demanded by any Commission, but which is of vast importance to the officers of the company. Under the liberal methods of dividing classifications, we are able to furnish this information for our own people without in any way impairing our ability to supply data to Commissions, but I can suggest no reason why any other company should subdivide to the same extent, as it is quite possible that in few other cases would such additional information be desired by anybody.

NORTHWEST LIGHT & POWER ASSOCIATION

The Northwest Light & Power Association which recently convened at Spokane conducted during the past year some interesting investigations into problems pertaining to electrical development in the Northwest. The two preceding papers by Norwood W. Brockett and C. N. Huggins are abstracts from papers delivered at the recent convention.

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Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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CONTENTS

Inland Empire

The leading article in the Journal of this issue deals in the electrical possibilities of the Inland Empire. The engineer engaged in hydroelectric development in the West is peculiarly fortunate in that he gets from his labors that inward satisfaction arising not only from the practice of his profession in the abstract, but the communion with nature he enjoys while gathering data in the mountains of the West, inspires him with the highest ideals. The world has long since known of the wonders of the Yosemite and the high-pressure power plants of the State of California. The rapid development, however, of the so-called Inland Empire, comprising the Columbia River drainage tributary to Spokane, has been brought about so quickly one can scarcely realize that a transformation from desert and undeveloped lands to high class orchard and farm tracts is each day nearing its completion.

As the great waves sweep inward to the shore, break upon its banks and there again drift outward, the tide of population first swept across the American continent, broke at the shores of the Pacific, and now is sweeping backward to the mountains, filling every available nook and inlet, thereby transforming them into fruitful productive valleys. So great has this impetus for increase of population been, it is found that Spokane, the distributing point of the Inland Empire, has become the center of a network of interurban electric lines third in size to any city in America.

This sudden gowth has led engineers and others interested in the industrial opportunities of the West, to investigate the future power possibilities of this resourceful country. The fruits of the investigation have proved of interest both to those of the aesthetic turn of mind and to the mind bent solely on affairs practical. In considering the aesthetic side of this great drainage district of our Western Empire, one is almost overcome with its beauties. When gazing upon the graceful bodies of water found in the Inland Empire leaping in their playful, joyous rush to the ocean, forming water falls of exquiste beauty crowned with mists of rainbow dew, one can almost imagine the frightened but graceful Arethusa of old, arising with honeyed lips from the waters, and in moments of playful fantasy, one can see her as she appeared to Shelley, when he wrote:

> "And gliding and springing
> She went, ever singing
> In murmurs as soft as sleep;
> The earth seemed to love her,
> And Heaven smiled above her
> As she lingered towards the deep."

But the all-fired practical man arouses the dreamer from his dreams, brings him back to earth, and behold he sees in this beautiful sight a poetry more delicate than words—a poetry to be sung by the "earth bound" in their relief from the burdens the latent water powers of the Columbia will bring. Hand in hand the development of all parts of the West must go. An empire to attract the attention of the world must be as varied and as diversified in interests and opportuni-

ties as old mother earth herself. The West is proud of its Inland Empire, and the continuance in its remarkable growth means another forged link in the fight for world-wide commercial supremacy.

Montana Water Rights

Elsewhere in these columns will be found an article dealing with the question of water rights in the State of Washington and slightly touching on usages in the States of Idaho and Oregon. The question of water rights has always been in the West one of the most vexing. The strife and conflict in California during the early days and, in fact, even down to the present has been a horrible example of lost time and energy, which could have been obviated by more clearly defined laws properly enforced.

Wyoming is today perhaps the most advanced State in the Union as regards the just and equitable operation of water right appropriations. When one travels through this thinly settled State in a study of the water usages there in vogue, one is struck very forcibly with the foresight used in planning the entire scheme of water districts and water commissioners. Much credit is due Elwood Mead, the noted irrigation expert, and a former State Engineer of Wyoming, for the model operation here seen.

The great State of Montana, immediately to the north, presents to the world a pitiful spectacle with its confusing system of appropriations and county jurisdictions. Most of the Western States have found the control of water appropriations by the State Engineer's office a most efficient scheme, as all water appropriations are thereby unified. In Montana, however, no such centralized scheme exists. An appropriator simply posts his notice and files the same in the local county clerk and recorder's office. At a subsequent date the district court, when properly petitioned, may adjudicate the waters of the stream. The consequence of this system is that in some parts of the State one inch of water to the acre is allowed by the courts for irrigation purposes, while in the neighboring district an entirely different basis is in vogue. The result is a diversity of rulings and complexity of status in water rights appreciated only by the hungry-eyed attorney, specially grafting on water right cases, but wholly unappreciated by the owner of the water rights, who desires stability of ownership and a reasonable disbursement for an equitable adjudication.

Such a primeval system was well-suited to the pioneer days of Montana, for water was so plentiful and inhabitants so few, clashes on water rights were infrequent. Today, however, Montana presents to the world the greatest possibilities in arid land reclamation of any State in the Union. Her water powers, now dormant, will soon demand the attention of the commercial world. It behooves Montana enterprise to awake to the critical situation of water right appropriations, and to place this most valuable asset in the great Treasure State on a more orderly and systematic status, so that their validity may be unquestioned.

Ground-Breaking World's Fair

The past week has put a happy countenance on the face of every true Westerner. The contagious smile of President William Howard Taft is mirrored in the expression of thousands. The words of the President at the ground-breaking exercises for the Panama-Pacific International Exposition are so sincere, so timely, and so kindly, that echoes of optimism and renewed hope and vigor are heard from the high crest of the Rockies on the East to the loud-roaring Pacific on the West. Those who live in our western empire have long since felt its charms and have become imbued with its boundless possibilities.

But to have our President come to the Coast, breathe our invigorating atmosphere, inspect our progress, and then tell us the good things he sees in store for us after the completion of the great Panama Canal, is almost enchanting.

The beginning of the upbuilding of the great exposition project, so auspiciously started by the President at the ground-breaking exercises during the past week, is now followed by an announcement of intense interest to those following the trend of affairs electrical at the great Panama-Pacific Exposition. Word has come from Gano Dunn, president of the American Institute of Electrical Engineers, announcing the enthusiastic reception accorded by the International Electrical Congress at Turin to the invitation issued by him in the name of the American Institute of Electrical Engineers to meet at San Francisco in 1915. Such technical gatherings in the past have indelibly left their impression on the technical world as mile-stones of accomplishment in the electrical art. The very getting together has spurred scientists and inventors to greater endeavor; and higher thought, keener intellect, broader human advancement have been the result.

Great investigators, in the study of sociological development, have found that the question of environment not only molds the future characteristics of the child, but in fact, shapes and sways the very destiny of human progress and advancement.

If this be the case, what of environment at the next International Electric Congress to be held in 1915?

The site as chosen by the Fair committee commands a sweeping background of the country eastward even beyond the Sierras to the distant Rockies; immediately in the background is seen the rebuilt San Francisco; while in front are the Golden Gate and the Pacific. Backed up by the boundless possibilities presented in hydroelectric development in the Sierras and Rockies; with the inspiration gathered from an immediate view of a city burned to earth, but arisen in greater splendor by the unparalleled efforts of a brave, fearless people; the gorgeous view to the west, stretching out of the Golden Gate to the entire world, should present such a dazzling picture of promise that the fruits of this gathering will unquestionably be thought and invention hitherto unknown.

PERSONALS.

Carl Holley, an electrical engineer of Visalia, is at San Francisco.

J. S. Johnson, president of the Visalia Water Works Company, of Visalia, is at San Francisco.

R. Q. Cleavenger, representative of the Phoenix Glass Company of Pittsburg, is at Los Angeles.

J. H. Newlin, purchasing agent of the San Joaquin Light and Power Corporation, is in the city.

H. E. Sanderson, Pacific Coast manager for the Bryant Electric Company, is again visiting Los Angeles.

R. B. Cartwright of Alhambra, who is connected with the Pacific Electric Company, is at San Francisco.

B. C. Ball, chief engineer of the Willamette Iron Works, of Portland, was a recent arrival at San Francisco.

H. M. Bishop, general manager of the South Sacramento Power Company, is a recent arrival at San Francisco from Sacramento.

A. G. Wishon, general manager of the San Joaquin Light and Power Corporation, of Fresno, was a recent arrival at San Francisco.

Guy W. Talbot, George F. Nevins, A. S. Greuner and George L. Meyers, prominent electrical men of Portland, were in Seattle recently.

Wallace W. Briggs, assistant sales manager of the Westinghouse Electric and Manufacturing Company, is at East Pittsburg on business.

W. R. Dunbar, a salesman in the Westinghouse detail and supply department, is also visiting the company's factory at East Pittsburg.

H. A. Russell, local sales agent of the General Electric Company, with headquarters at San Francisco, is spending a month in New York.

John S. Baker, Pacific Coast district manager for the Crocker-Wheeler Company, of Ampere, N. J., is at Los Angeles on electrical business.

A. B. Saurman, manager of the Pacific Coast department of the Standard Underground Cable Company, is making a tour of the Pacific Northwest.

W. P. Hammon, the head of the California-Nevada Power Company, is again at his San Francisco office after spending two months in the East on business.

J. E. Poindexter, a district manager of the Pacific Gas and Electric Company, with headquarters at Marysville, is among the recent arrivals at San Francisco.

W. E. Chase, of Plummer, Idaho, who has a large contract for electrical equipment at a Puget Sound fort, was in Seattle recently on his way to the contract to supervise the work.

R. G. Hanford, one of the vice-presidents of the United Properties Company, is at New York on an important financial mission connected with the extension of the corporation's activities.

W. L. Huber, district engineer, who has jurisdiction over water powers in District No. 5, United States Forest Service, is at San Francisco after spending some time on the forest reserves.

J. A. Vendergrift has just returned to Oakland from Los Angeles, where he has been in consultation with S. E. Doane, chief engineer of the National Electric Lamp Company of Cleveland, Ohio.

Ex-United States Senator Eli Whitney, who is at the head of the principal electric power company supplying New Haven, Conn., with current, is at San Francisco on a tour of the Pacific Coast.

H. C. Goldrick, Pacific Coast manager of the Kellogg Switchboard and Supply Company, of Chicago, left for Portland last Tuesday and will close up some pending business in his line in the Northwest.

J. D. Holmes, general manager of the Home Telephone and Telegraph Company, is at San Francisco investigating the latest pole line practice under the new city regulations, with a view to adopting the improvements observed.

A. L. Jaqueth, engineer, has assembled a crew of several assistants at Kalispell, Montana, and has inaugurated work on the survey for the Flathead interurban electric line. Sites are being secured for car shops and other traction facilities.

J. H. Wise, assistant general manager of the Pacific Gas and Electric Company, is visiting Lake Fordyce with H. C. Vensano, the company's civil engineer, in connection with the tunneling and other hydro-electric work in progress on the South Yuba system.

Leon M. Hall, electrical engineer, has returned to his San Francisco office from Coalinga after doing some preliminary work on a dam which is to be constructed for irrigating the Avenal Ranch of Balfour, Guthrie & Co., and other properties in that district.

R. F. Chevalier, testing expert, of San Francisco, and E. S. Ferrier, assistant electrical engineer of the Southern Pacific Company, are receiving the heartfelt thanks of the sophomore engineering students of the University of California for the able and interesting manner in which they recently conducted the students through the Fruitvale plant of the Southern Pacific.

Gano Dunn has just returned from abroad, where, as a representative of the United States Government, and as president of the American Institute of Electrical Engineers, he has been attending the International Electrical Congress at Turin and the meeting of the International Electro-Technical Commission, the body that has been organized to bring about international uniformity of standards and practice in the electrical industry. Mr. Dunn, who for many years was first vice-president and chief engineer of the Crocker-Wheeler Company, and is a past president of the New York Electrical Society, has been elected a director and a vice-president of J. G. White & Company, Inc.

ELECTRICAL CONTRACTORS' NOTES.

H. W. Jacobs, an electrical contractor of Santa Rosa, is at San Francisco.

Ivan Berry, who is in the electrical business at Los Angeles, is a San Francisco visitor.

D. W. Thomas, an electrical contractor of Petaluma, was visiting the San Francisco supply houses during the past week.

Apropos of building up loads for central stations, R. D. Holabird of the Holabird-Reynolds Company, states that a certain power company decided to exploit the sale of electric flat irons and other electric appliances among the consumers on its circuits. This decision was reached about two years ago. During this comparatively brief interval the income from current consumption necessary to operate the appliances that have been sold has increased until it is now sufficient to pay the interest on $1,250,000 of the power company's bond issue. All this was accomplished practically without the addition of a single new transformer, or meter, and 85 per cent of the current consumed by these appliances is "off-peak" load.

OBITUARY.

Otis Carter Post, of the switchboard sales department of the Westinghouse Electric & Manufacturing Company, died suddenly of cerebral embolysm at his residence in Wilkinsburg, Wednesday night, September 13. His death will be sad news to the host of friends he has made.

Everett Copley of the New York sales office of the Westinghouse Electric & Manufacturing Company, died at his home in New York on Thursday, September 27, of typhoid fever. About three years ago he entered the New York sales office of the Westinghouse Company, where his great capability and thorough knowledge of electrical work soon gained for him the admiration of his fellow employes and a bright future was the prediction of everyone associated with him.

TRADE NOTES.

Thomas Mirk, of Hunt, Mirk & Co., is at San Diego to start work on a new contract. It includes installing for the San Diego Electric Railway Company an underground steam heating system. The waste steam from the railway power plant will be utilized. The system of mains adopted is that of the American District Steam Heating Company of Lockport, N. Y.

The General Electric Company has sold to the Centralia Light and Traction Company of Centralia, Wash., one A.T.B. 2, 500 kw., 8 p.f., 625 k.v.a., 3600 r.p.m., 2300 v., horizontal Curtis turbine generating set arranged for 200 lbs. steam pressure, and 2 inches absolute back pressure. Accompanying the above is one C.C. 2, 7 kw., 5000 r.p.m., 120 v.-125 v., non-condensing Curtis turbine exciter set.

J. H. Hansen, hydraulic engineer, with the Pelton Water Wheel Company, has returned to the San Francisco manufacturing plant after spending some time in Southern California in consultation with officials of the Pacific Light and Power Company. The Pelton Company is remodelling the Borel power station near Caliente. Three 3000 kw. generating units are to have their present wheels replaced with three Pelton-Francis turbines. These massive machines, having cases weighing 14 tons each, are being constructed at San Francisco.

The Globe Grain and Milling Company, after a year's trial of electrical operation of their flour mill at Los Angeles with Westinghouse induction motors aggregating 400 h.p., are so satisfied with the resulting economy that they have decided to electrize their San Francisco plant throughout. Standard Westinghouse C. C. L. motors, aggregating 700 h.p. have been ordered. The main drive will consist of two 250 h.p. induction motors. This will be the largest electrified flour mill on the Coast, and probably it ranks next to the big flour mills at Minneapolis.

The Farnsworth Electrical Works of San Francisco report the sale of a complete generating plant and transmission line equipment to the Gray Eagle Gold Mining Company, in Sierra County, Cal. This includes the installation of a 125 kw. second-hand G. E. three-phase, 2300 volt generator with necessary switchboard equipment, together with three 15 kw. three 10 kw., three 5 kw. and one 6 kw. transformer, one 30 h.p., two 20 h.p. and one 10 h.p. motors, as well as material for 1½ miles of transmission line. The generator will be driven by a Samson low pressure turbine. The Farnsworth company has also built a 75 kw. 6600 volt transformer to the order of the Alta Bert Gold Dredging Company in Trinity County, California.

The H. W. Johns-Manville Company, 100 William street, New York, is putting on the market a waterproofing fabric which is a strong, loosely woven burlap impregnated with pure asphalt. It is advanced for this that it not only clings but becomes locked into the fabric. It is claimed that a few layers of it makes a waterproof course of great strength, ductility, and so forth, also that it remains intact and resists moisture even when cracks occur in the cement work. The company is putting on the market a waterproofing asbestos felt, which being composed only of mineral substance is stated to be especially adapted for waterproofing all exposed and foundation construction work. A waterproof coating is also being offered which is a combination of carefully selected materials. It is claimed when this is applied that moisture can not penetrate it. The Seattle office of the company is at 1020 First avenue South.

MEETING NOTICES.

The sixth congress of the International Association for Testing Materials, will be held at the Engineering Societies Building, New York City during the week beginning September 2, 1912. The society has the highest aims possible in advancing an important adjunct to engineering progress and merits the support of all engineers.

The San Francisco Branch of the American Institute of Electrical Engineers will meet at the Home Telephone Company's Building at 8 p. m., October 27th. C. F. Elwell will present a paper on High Tension Direct Current Transmission. The discussion will cover the Thury system in vogue in European installations.

The San Francisco members of the American Society of Mechanical Engineers attended a banquet at the Fairmont Hotel on the evening of October 17 in honor of E. D. Meier, the national president. The matter of holding a national meeting at San Francisco at the time of the Panama Pacific Exposition was thoroughly discussed and will receive the enthusiastic support of President Meier.

BOOK REVIEW.

Cyclopedia of Telephony and Telegraphy. Prepared by a corps of telephone and telegraph experts, and electrical engineers of the highest professional standing; size 6½x9½ inches; 1572 pages, bound in four volumes; illustrated with over 2000 engravings. Published by the American School of Correspondence of Chicago, and for sale by Technical Book Shop, Rialto Bldg., San Francisco. Price, —.

The book is thoroughly what it purports to be—a cyclopedia of telephony and telegraphy. The very brainiest men in American engineering adorn its list of experts employed in the compilation of data contained winthin its pages. In spite of the fact that America's foremost engineers have contributed to its pages the real object has never been lost sight of—that of explaining in a clear, simple, precise manner the workings of the great telephone and telegraphic art. The book is indispensable for those engaged in the telephonic or telegraphic profession and who desire a clear, simple and exhaustive treatment of the subject.

Electric Traction and Transmission Engineering. By Samuel Sheldon and Erick Hausman. Size 5½ x 7½ inches; 307 pages; 127 illustrations; clear type; cloth binding. Published by D. Van Nostrand Company, of New York, and for sale by The Technical Book Shop, Rialto Bldg., San Francisco. Price, $2.50.

The authors of this book are well known both to the technical educational world and those interested in affairs practical. The book is ambitious in its scope, attempting to cover a complete railway installation, from the cars to the power station, to indicate the nature and sequence of the various entailed problems, and to suggest or illustrate methods for their solution. Illustrative examples are solved and a list of problems appended at the end of each chapter. The book covers a field hitherto touched upon in separate details only. It combines steam-turbine installation along with the electrical problems. The recent impetus given to installation of central station steam auxiliaries on the Pacific Coast will make the book useful to Western engineers.

INDUSTRIAL

PROTECTIVE RESULTS ACCOMPLISHED BY ARCING RINGS ON TRANSMISSION LINES.

During the early part of this year, a very interesting paper was read before the American Institute of Electrical Engineers at Charlotte, North Carolina, describing a 60,000-volt transmission line of the Niagara, Lockport and Ontario Power Company. The paper dwelt particularly upon the remarkable amount of protection the transmission line had received by applying metal arcing rings to the insulators as illustrated in Figs. 1 and 2.

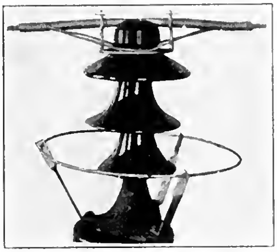

Fig. 1 High Tension Insulator Equipped With Arcing Ring.

These rings save the insulator from injury when the transmission line is struck by lightning, which is usually followed by the consequent flashover arc. They are placed in such a position as to attract the arc and hold it sufficiently removed from the porcelain to prevent breakage from the heat engendered. The puncture of the insulators is also prevented by the rings without their lowering the effective insulation of the line. During the season of 1910, which was a severe one, practically 410 miles of the transmission line above referred to was equipped with arcing rings. Comparing

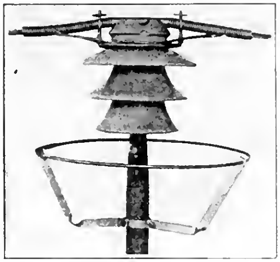

Fig. 2. Protected Insulator on Top Wire.

this season to that of 1908, both of which were severe, a good conception of the effectiveness of the protective measures adopted is shown. In 1908, 220 insulators were destroyed; 31, it was determined, from direct lightning strokes, judging from the characteristic manner in which they were broken up, 114 were punctured and 81 were destroyed by power arc following flashovers. In 1910, 26 insulators were lost; 17 by direct stroke and 9 by puncture. None were destroyed by power arcs on either line and none by puncture on the re-insulated line. The loss by direct stroke was practically equally divided between the lines.

These results show that the destruction of insulators by power arcs has been eliminated. That sound insulators protected by arcing rings fail only by direct lightning stroke and that arcing rings greatly reduce the tendency to puncture by induced potential effectiveness and do not prejudice the effective installation of the line.

The Locke Insulator Company have taken over all the patent rights of the arcing ring device shown in Figs. 1 and 2 and will handle their entire commercial development.

H. W. JOHNS-MANVILLE COMPANY'S EXHIBIT.

H. W. Johns-Manville Company of New York City, are making an unusually complete and interesting exhibition of J-M Products for Electric Railway Service at the American Electric Railway Association Convention at Atlantic City, N. J.

Among the many J-M railway products exhibited, the following are especially worthy of note:

J-M Fibre Conduit, which is manufactured in two styles known as Bell Joint and Straight Joint Type, together with complete line of fittings consisting of elbows, tees, crosses, junction boxes, etc.

The J-M Linolite System of Lighting is employed in illuminating the company's exhibit, and this mode of lighting is now widely used for show windows, show cases, sign lighting and indirect illumination because of its distribution of light and the marked economy in current consumption.

A complete line of Overhead Trolley and Transmission Line fittings which include many improvements and refinements recently made, is one of the features of the J-M exhibit and attracted a great deal of attention and interest.

Some interesting specimens of J-M Transite Ebony Asbestos Wood are also displayed.

"Noark" Car Fuse Boxes in various sizes occupy a prominent place in the exhibition and a complete line of "Noark" National Electrical Code Standard Protective Devices such as Fuses, Cutouts, Service Switches and Fuse Boxes are also well represented.

A new soldering paste which combines solder and a non-corrosive flux contained in a collapsible tube was also shown, known as "Solderall." J-M Friction Tapes and Splicing Compounds which are made in many grades to suit all conditions were well represented.

NEW LONG LIFE FLAME ARC LAMPS.

The new Type "K" long life flame arc lamps now being placed on the market by the General Electric Company are

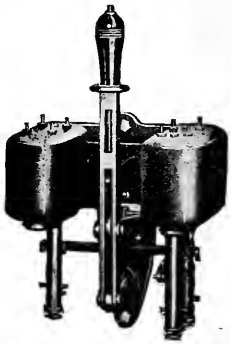

Fig. 1. G. E. Motor Circuit Direct Current Long Life Flame Arc Lamp. Mechanism.

available in four styles—K-28 for operation on series alternating current, K-36 on multiple alternating current, K-51 on multiple direct current, and K-43 on power circuits, of all commercial voltages.

The mechanism is of the focusing type, automatically maintaining the arc in the same position, thus affording a

constant and even distribution of light. A clutch of ingenious design permits the use of carbons varying considerably in diameter, and obviates all pick-up troubles due to clutch wear, thus insuring a perfect feed. The chain wheel is made of alloy with separate grooves for the upper and lower carbon holder chains. As the upper chain unwinds the lower winds, thus keeping the arc always in the same position. The cores and coils are suspended by means of compression springs to prevent any flickering of the arc when the lamps are hung in places subject to vibration. Except in the series lamps no shunt spools are used, thus eliminating a prolific source of arc lamp complaints.

of the upper carbon cut off to the proper length in the lower holder, and replace the globes. The necessity for using only one new carbon at a trim greatly reduces the cost of maintenance, while the homogeneous structure of the carbons affords many advantages over the cored type. The size of the carbons—⅞ inch diameter, 14 inches long—gives great mechanical strength and decreases the breakage in handling.

The principle of ventilation applied allows the hot gases rising from the arc to circulate through the condensing chamber where they are cooled and the fumes condensed and deposited, thus keeping the inner globe clean and the illumination unimpaired. The casing is made of either copper or

Fig. 2. G. E. Multiple Alternating Current Long Flame Arc Lamp. Mechanism.

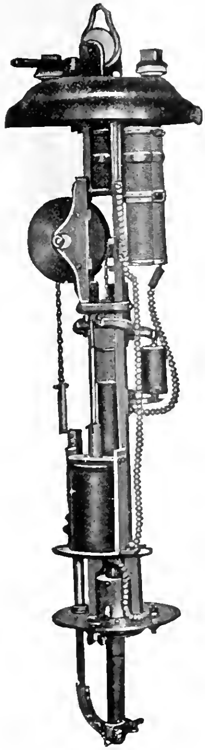

Fig. 3. G. E. Multiple Direct Current Long Life Flame Arc Lamp. Mechanism.

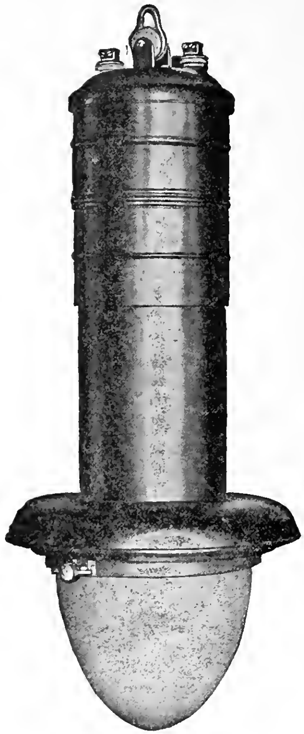

Fig. 4. G. E. Long Life Flame Arc. Exterior.

The lamps are provided with two globes. The inner globe may be of either clear or opalescent glass. Its open end is ground smooth and makes an air-tight joint with the machined surface on the under side of the condensing chamber against which it is held by a phosphor bronze bail spring. The outer globe is furnished in opalescent glass on the standard lamps, but may be obtained in clear glass. The method of holding the outer globe greatly simplifies the operation of trimming. The complete globe holder is hinged to the condensing chamber, a retaining spring holding the outer globe in position uniformly and without pressure. To lower the outer globe for trimming it is only necessary to loosen the wing-nut provided and allow the globe to swing downward where it is out of the way. This arrangement obviates the necessity for removing the globe, thus preventing the liability of its swinging in the wind and breaking by striking against the pole. The lamps may be used without the outer globe.

To trim, it is only necessary to lower the outer globe, take off the inner, remove the stub of the upper carbon, press the new upper carbon firmly in the spring holder, insert the stub

steel and is of the telescopic type to permit the ready examination of the entire lamp mechanism for adjustment or repairs without removing the condensing chamber or globes. The dome is a steel punching possessing great mechanical strength.

The arc voltage on the multiple alternating current lamp is regulated by a reactance, on the multiple direct current lamp by a resistance, and on the power circuit lamp by a resistance and a weight for properly balancing the arc voltages when two lamps are burning in series. In all the lamps the respective reactances or resistances are located within the lamp casing. The clutch rod regulates the distance from the top of the armature to the clutch lever, the proper arc pick-up being between ⅞ and 1⅛ inches.

The series alternating-current lamp has an efficiency of .24 watts per mean hemispherical candlepower, and the multiple alternating-current and multiple direct-current lamps have efficiencies of .28 and .41 watts, respectively. The series lamps have a life of 90 to 100 hours, the multiple lamps 100 to 120 hours, thus combining high efficiency with long life.

NEWS NOTES

INCORPORATIONS.

LOS ANGELES, CAL.—The Sunset Beach Gas & Electric Company has been incorporated for $25,000 by C. W. Gower, F. W. Norman and H. Pierce.

VISALIA, CAL.—The Central Counties Gas Company has been incorporated for $500,000, by F. H. Hess and H. W. Ritz of Porterville, N. F. Jamieson, M. Hesselberger, and C. F. Ritz of Los Angeles.

FINANCIAL.

EUGENE, ORE.—The City Council has passed an ordinance providing for the sale of $25,000 of electric light bonds.

REDLANDS, CAL.—The City Trustees will call a special election at the next meeting to submit the question of issuing $750,000 bonds for a municipal water system.

FALLS CITY, ORE.—The special election on the additional $5000 water bonds issue, resulted in favor of the issue, insuring the extension of the present water system.

LOS ANGELES, CAL.—The City Clerk will receive sealed bids up to October 23 for the purchase of $520,000 Harbor Improvement Bonds and $525,000 Electric Plant Bonds of the city.

YERINGTON, NEV.—Bids will be received by the City of Yerington, Nev., for $36,000 waterworks bonds of said city, bearing interest at the rate of 6 per cent per annum; dated September 1, 1911.

RED BLUFF, CAL.—The Supervisors of Tehama County have decided to cancel the insurance of the bridge at Tehama across the Sacramento River of $43,000 and install a water system for the protection of the bridge from fire. County Surveyor Luning has been ordered to prepare plans and specifications for a water system for the bridge.

FRESNO, CAL.—The interest money, amounting to a little over $2500 which was expected from the Hudson Counties Company to pay local bondholders in the Fresno, Hanford and Summit Lake Railroad Company, has arrived and been distributed. Directors of this railroad take the receipt of the interest money as a good omen.

SACRAMENTO, CAL.—The Sacramento Natural Gas Company has filed amended articles of incorporation with the county clerk in which it announces its determination of entering into a bonded indebtedness of $400,000 to be used in extending its business and supply system and to pay off present and future debts. This step was decided on at a meeting of the directors and stockholders on August 28.

OAKLAND, CAL.—After several months of conference F. A. Leach Jr., manager of the Oakland Gas Light and Heat Company, informed Mayor Mott in Oakland Saturday that his concern had agreed to reduce its rates. Beginning on November 1, Leach said, the company would make a maximum rate of 90c for gas for all purposes, with a sliding scale, making the minimum rate 75c per thousand cubic feet for gas in large quantities. The existing rates are 90c per cubic foot for fuel purposes and $1 for illuminating purposes.

LOS ANGELES, CAL.—In a message to the City Council the Mayor said that he endorsed the recommendation of the Board of Public Service to submit to the voters the question of issuing bonds for providing an electric distributing system. He also recommended that the bonds for a municipal railway be submitted to the voters at an early day. The latter part of his recommendation received little attention, but the proposal, which calls for issuing $5,500,000 in bonds, with regard to distributing the electric power that is to be generated from the aqueduct, was referred to the finance committee. The city clerk was directed to advertise for bids for $520,000 worth of harbor bonds and $525,000 worth of aqueduct power bonds, the total issue of which is to be; harbor bonds, $3,000,000, and aqueduct power bonds $3,500,000. By going into the open market with these bonds, the use of the sinking fund for investment in the bonds is not followed at this time, as was originally proposed.

PORTLAND, ORE.—Nine million of British capital will be available in Portland within 90 days for the development of the great individual power project in the Pacific Northwest. The money is to be used for the construction of huge dams at the Deschutes River, near its mouth, which will be capable of developing a minimum of 75,000 horsepower, This will be done at a cost of $7,500,000. The new syndicate will be known as The Deschutes Rimrock Power Company, and is being capitalized at $1,000,000. Its president will be Malcolm A. Moody. The secretary and treasurer will be Leroy Park.

TRANSPORTATION.

REDLANDS, CAL.—The street car line from Orange street via east Colton avenue, to University street, is now assured. Operations will begin immediately.

PACIFIC GROVE, CAL.—The Monterey and Del Monte Heights Railway is to be completed at once, and cars will be running out to Del Monte Heights by December 15th.

ABERDEEN, WASH.—The City Council has granted a franchise to the Grays Harbor Railway & Light Co., in which the company is given permission to extend its local tracks.

PACIFIC GROVE, CAL.—H. R. O'Bryan and his associates are preparing to construct a railroad from Broadway in the Del Monte Heights tract to the Hot Springs, where they are making arrangements to erect a pleasure resort.

BUHL, IDAHO.—The Twin Falls County Railway Company has received a franchise for the construction of an electric road here and in the vicinity. The line will eventually traverse the entire district in this section of the state.

SEDRO-WOOLLEY, WASH.—Bids will be received by the State Board of Control up to November 6 for the erection of a concrete and steel power house, also for mechanical equipment, boilers, engines, etc., to be installed in the power house.

RAYMOND, WASH.—The Twin City Electric Railway, now being built between Raymond and South Bend, received its first car of steel rails, which will be laid at once. The company expects to have the line in operation by January 1.

SAN JOSE, CAL.—C. P. Anderson has applied to the Supervisors for a franchise to operate by gas or electricity a standard gauge railroad in the County of Santa Clara. Bids will be received up to 10 a. m. November 4. H. A. Pfister, clerk.

SACRAMENTO, CAL.—Word has been received here that President T. T. C. Gregory of the Sacramento-Woodland Railroad has let contracts for construction work on two sections of the road. The Dozier Construction Company has been awarded the contract for that section of the line between Woodland and Elkhorn, while Cooper & Hawley are to handle the construction of another section. Work will start next week. Bids will soon be called for on the bridge trestle 10,000 feet long across Yolo basin.

PORTLAND, ORE.—The Portland Railway, Light & Power Company will erect a $1250 steel tower at the foot of Virginia street, 26x26 by 85 feet high, also a $2500 steel tower on the opposite of the Willamette River on River Front street, 27x27 feet, 100 feet high.

SAN DIEGO, CAL.—The management of the San Diego Electric Railway Company announces that extensive improvements will be made here. Pay-as-you-enter cars will be put in service. The company will also extend lines and double track lines that are now single track.

SAN BERNARDINO, CAL.—The Southern Pacific Company will build an electric line from Redlands to Yucaipa Valley instead of constructing the new main line from Beaumont to Redlands, through Eucaipa. This will be a portion of the San Bernardino Division of the Pacific Electric.

SEATTLE, WASH.—The Board of Public Works has approved plans as prepared by the city engineer for the construction of a municipal street railway from Steward street to Thorndyke and Twelfth avenue. After a few details have been adjusted the Board of Public Works will issue a call for bids on this section.

SAN FRANCISCO, CAL.—Mayor McCarthy has approved the resolution passed by the Supervisors rescinding the temporary permit of the Geary Street, Park and Ocean Railway to operate its cable cars and directing it to stop running in 14 days. The last day for the operation of the old cable road will, therefore, be October 19.

OAKLAND, CAL.—A deed has been placed on record conveying 2200 acres of land in and around Newark, in Alameda County, to the United Properties Company, owners of the Key Ronte. The Newark Development Company, of which Harvey M. Toy is president and sole owner, is the seller of this land. The price paid was about $600,000.

LAKEPORT, CAL.—The directors of the Clear Lake Railroad have authorized the construction of nine miles of roadbed, four miles out of Hopland and five miles southwest of Lakeport. The company is capitalized at $500,000 to build from Hopland to Lakeport, a distance of 24 miles, with branches through Kelseyville and Upper Lake.

OAKLAND, CAL.—With the purchase of the Chris Jessen property at Oakland and Peralta avenues, the Key Route secured the last link in its right of way between Oakland and San Jose. Within two weeks, it is understood, active construction work on the new line will commence as necessary surveys have been completed and material ordered.

WENATCHEE, WASH.—The Wenatchee Traction Company has been granted a franchise for the construction of an electric railway on certain local streets. The sum of $5000 has been deposited to guarantee construction within six months. The line will be built along the Columbia river valley, it is reported, with extensions to make a total distance of 100 miles. Date of receiving bids on above has been extended from October 16 to November 6.

ILLUMINATION.

POMEROY, WASH.—E. M. Rauch has made application to the City Council for a franchise to operate a gas plant for 25 years.

ABERDEEN, WASH.—The Council is discussing the question of establishing a light plant to be owned and operated by the city.

COLTON, CAL.—The City Council passed an ordinance authorizing the president of the Board of Trustees and the city clerk to execute a certain contract with the Southern California Edison Company for lighting the streets of the city.

ELLENSBURG, WASH.—This city will install cluster lights along the principal streets the coming spring.

WATTS, CAL.—An ordinance granting a fifty-year franchise to the Pacific Light & Power Company has been carried unanimously.

FULLERTON, CAL.—The city has signed a contract for a term of five years with the Southern California Edison Company for an improved system of street lamps, which will be installed at once.

ALHAMBRA, CAL.—The Board of Trustees has discussed the proposed ornamental lighting system for North Marguerita avenue, and it was agreed that 12 posts be installed with three lights each.

LOON LAKE, WASH.—Gehrke & Sons, local millers, are making a canvass of the town to ascertain what patronage can be secured for an electric lighting system and state if as many as 200 lights can be secured they will install an electric plant.

VALLEJO, CAL.—The residents of the O'Hara tract are to have electric lights and power. Manager Albert Casper of the Vallejo Electric Light & Power Company, has announced that he intends to run a pole line to the tract immediately.

PERRIS, CAL.—The City Council has passed an ordinance granting to Fred B. Mechling a franchise to maintain, for a period of 50 years, an electric pole and wire system for transmitting electric light, heat and power along the public streets of this city.

CORVALLIS, ORE.—Col. Wm. Hamilton McGoldric wants to install a modern gas, light, heat and power plant in Corvallis and has asked the City Council for a 50-year franchise, agreeing if the same is granted to have the plant in full operation by December 31, 1912.

SAN BERNARDINO, CAL.—If a sufficient number of residents of Rialto District will agree to use gas as soon as the system is installed in that community, Manager Grow of the Southern California Gas Company, says they will agree to have the system in operation by Christmas.

SPOKANE, WASH.—Commissioner Fasset has recommended favorably on the petition of Second avenue property owners for the installation of electroliers along the avenue. An improvement district will be created to defray expenses of the electroliers and the city will pay a portion of maintenance cost.

MILL VALLEY, CAL.—The Mill Valley Gas Company, which was organized recently, has received its first shipment of pipe and the company is now engaged in placing it along the streets of the town. The company promises to supply gas to consumers by February 1, 1912. The Pacific Gas & Electric Company intends to supply Mill Valley with gas the early part of the year.

TELEPHONE AND TELEGRAPH.

ASTORIA, ORE.—The Centennial Telephone Company, which has been organized for the purpose of constructing a telephone line from this city to Jewell and Elsie, has awarded a contract to Damon Stinson for stringing the wire for the proposed line.

PORTERVILLE, CAL.—Residents of the Worth district of the upper Tule have organized an independent telephone company, to be known as the Rosedale Rural Telephone Company. The officers are: A. Chalmers, president; E. O. Giddings, vice-president; M. Giddings, secretary, and J. E. Reilly, treasurer. C. H. Weed and Peter Von Ting are the other members of the board of directors. Work is to start

at once on a line to run from this city to Worth, on the south side of the river, including the orange groves of the Worth district, and returning to Porterville on the north bank of the river.

TRANSMISSION.

SAN FRANCISCO, CAL.—The Sierra & San Francisco Power Company has advised the City Council of Berkeley that it is preparing to establish a plant in Berkeley.

The Taylor Chemical Company, Penn Yann, N. Y., have ordered from the General Electric Company one 625 k.v.a horizontal turbo-generator, one 7 kw. 125 volt horizontal turbo generator, two 250 k.v.a. transformers and a switchboard.

BEND, ORE.—The Council has passed an ordinance authorizing giving the Bend Water, Light & Power Company the right to construct a system of poles, wires in the alleys and public ways of the city for the purpose of furnishing light and power to citizens of the city.

BOISE, IDAHO.—It is reported that the Kuhns of Pittsburg, who recently secured a power franchise in South Boise, will shortly apply for a franchise in this city. It is also rumored that the Beaver River Power Company will also endeavor to secure a franchise here.

VANCOUVER, B. C.—The Western Canada Power Company has acquired a site on Powell street, near the yards the British Sugar Refinery Company for the immediate erection of a building to be equipped in time to receive power from the company's hydroelectric plant at Stave Falls. A warehouse will also be erected on the property.

VANCOUVER, B. C.—It is reported that the Canadian Pacific Railway has acquired a water power site on the Adams river. The Adams river, which flows out of Adams lake, is capable of developing 10,000 h.p. between the lake and its confluence with the South Thompson River. The railway acquired the power site in connection with its intention of electrifying a portion of its line in the mountains.

PORTLAND, ORE.—Engineers representing the Pacific Power & Light Company of this city are preparing to go into the field to make surveys for a high power transmission line between Wallula and The Dalles for the purpose of serving electricity to the territory between these places. The line is to be 130 miles long and to cost $375,000, and built to carry a heavy load at 66,000 volts. As soon as the surveys are completed material will be ordered.

SACRAMENTO, CAL.—The Pacific Coast Gas and Electric Company has started work in the northern part of the city on the new steam relay station. Dredging and piledriving are under way and work will be pushed on the early installation of a 5000-kw., horizontal Curtis steam turbine generating set. Stirling boilers, with auxiliary apparatus will be installed for an ultimate capacity of 12,500 kw. A 7500-kw. horizontal Curtis turbine is on delivery and will be installed later. It is the company's intention to give Sacramento the best service possible.

STOCKTON, CAL.—The Sierra & San Francisco Power Company has entered the local field. H. Jackson, assistant manager of the company, states that his workmen have started the work of extending their lines from Manteca to Stockton. He says: "The Sierra and San Francisco Power Company is in no way connected with any other corporation. We have a capitalization of $20,000,000 and backing to the extent of $10,000,000. We will expend not less than $200,000 in Stockton, which will include an auxiliary plant to protect our patrons in case our hydroelectric plant on the Stanislaus River should fail temporarily."

WATERWORKS.

WAPATO, WASH.—The City Council has passed an ordinance providing for the sale of municipal water bonds to defray the cost of the construction of a municipal water system.

GRANGER, WASH.—Town Engineer N. W. Avery has been instructed by the Town Council to prepare the plans and specifications for a modern water works system for Granger.

WOODLAND, CAL.—The contract for the boring of another city well has been awarded to Bender Bros. of this city. They will receive $5.50 a foot for the first 70 feet and $3.75 a foot from 70 feet to 200 feet.

BRIDGEPORT, CAL.—The firm of Fairbanks, Morse & Co. has been awarded the contract to install the water system at the court house for the sum of $3323, including all charges for the freight on supplies, machinery, etc.

BEND, ORE.—Th City Council has passed an ordinance authorizing the Bend Water, Light & Power Company to construct and operate a water system for the purpose of furnishing and supplying water to the public of that city.

ELMA, WASH.—By an overwhelming majority the Wenzell, Wash., Springs water proposition, and the issue of ten thousand dollars in bonds for the extension of the present water system were endorsed by the people of Elma.

SIERRA MADRE, CAL.—The City Trustees have adopted the special election ordinance for an election to be held November 7 to vote on the question of issuing $111,000 bonds for the purchase of the property of the Sierra Madre Water Company, and for development of more water.

KLAMATH FALLS.—The electric lighting service of the local company, which was recently put out of service for some hours by a wind storm that blew the water out of Link River into the Upper Klamath Lake and also caused short circuiting of the lines, is again in perfect working order. George J. Walton is general manager of the company.

BARSTOW, CAL.—The Westwater Power Company has sold its holdings to the Arrowhead Reservoir & Power Company who now hold most of the water in the Mohave River. This company will erect a power plant at the head of the river and furnish power for the valley and desert.

ELLENSBURG, WASH.—According to Samuel Kreidel, chairman of the council's special water commission, an ordinance will be passed making Ellensburg a special improvement district, bonded to pay for the recently authorized $150,000 municipal water works. The water works will be erected near the county poor farm, seven miles north of town and preparations for securing the right of way for the pipe line to the city are well underway.

FORTUNA, CAL.—The stockholders of the Fortuna Water Company are preparing to sink a well with a sufficient flow of water to meet the requirements of this fast-growing city. A committee, comprising F. A. Leach, L. C. Morgan and A. C. McArthur, have been named to select a site for the well that in their opinion would furnish the required flow of water.

WHITTIER, CAL.—After hearing from the water superintendent on the matter of improving the water conditions in the vicinity of the college, the City Aldermen decided that a four-inch main is necessary. Work will be started at once laying the pipe from the large main which hits the city limits on East Philadelphia street. A pipe line will be run along the city limits.

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LONG BEACH POWER PLANT

BY A. H. HALLORAN.

The Southern California Edison Company has completed and is now operating the first unit of its great steam plant at Long Beach near Los Angeles, California. The prototype for an ultimate development of eight similar units and embodying the latest and most improved practice in the generation of electric power from fuel oil, this initial installation of a 15,000 kilovolt ampere turbo-generator and accessories is of considerable interest. It is designed as an auxiliary to the Company's six hydroelectric plants on Mill Creek, Santa Ana River, Lytle Creek, Kern River and is primarily intended to take care of peak loads and to insure the consumers against the service interruptions so liable in the long distance transmission of electric power from distant water plants.

Fig. 1. General View of Long Beach Power Plant During Construction.

The site is well chosen, both as regards ample space for plant expansion and abundant water for steam condensation. Situated on a ten acre plot of

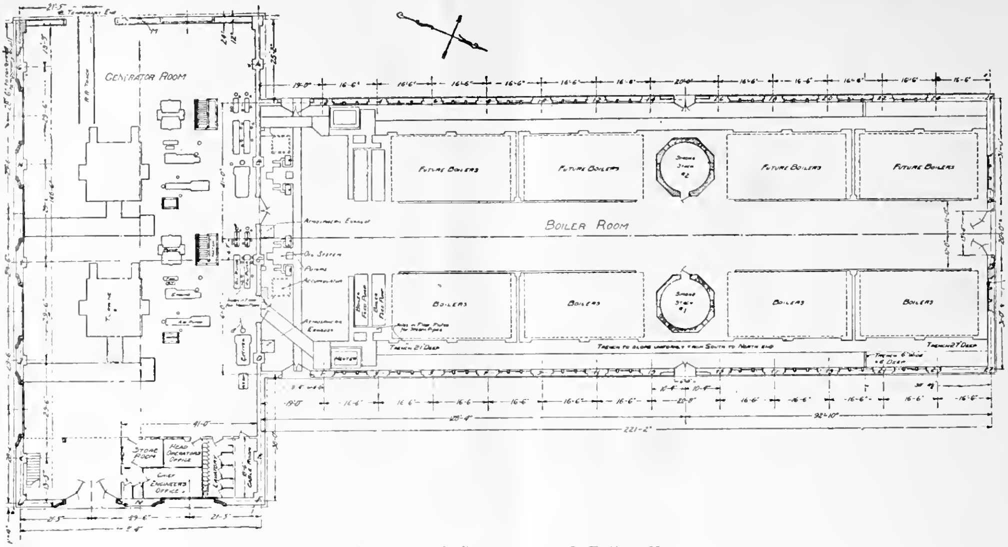

Fig. 2. Plan of Generator and Boiler House.

ground where the Long Beach Inner Harbor channel joins the Pacific Ocean, a never-failing source of cold sea water will always be available. For the present installation, however, the Inner Harbor channel suffices to supply the circulating water, giving greater freedom from bubbles, sand and seaweed than would a surf pier.

The accompanying picture illustrates this situation in a most striking manner and also shows the intake, the transformer house, the generator and boiler house and the discharge conduit during construction.

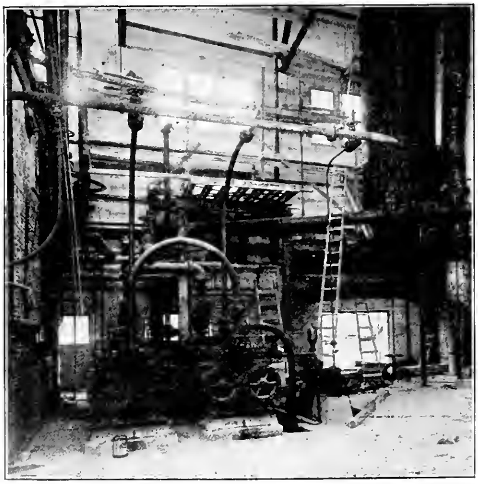

Fig. 3. Boiler Feed Pumps.

The two main buildings are reinforced concrete structures with steel roof trusses and concrete roof slabs. Ornamental copper cornices and artificial stone bases and abuttments lend a most pleasing appearance which is further enhanced by the mission tile roofing and smooth plaster finish, inside and out. The foundations for the building and the heavier machines are carried on piles. The generator room is floored with tiling and glazed tile is used in the wainscoting. The windows are of metal sash.

The generator and boiler house has a floor area of 30,000 sq. ft. and stands 60 ft. high. The accompanying line drawing shows the general layout for the first two units and indicates the ease with which the system can be extended. As will be noted, each unit comprises a prime mover and generator with its condenser and attendant auxiliary machinery, together with boilers and independent switchboard equipment. This arrangement has many advantages, not the least of which is that during construction each unit can be completed and put in operation without waiting for other portions of the plant. The switchboard gallery extends across the east end of the turbine room and commands a view of the entire generating floor. Under it are various offices, store rooms, etc., and over it are the rheostats and storage batteries. A 50 ton Shaw crane with a 5 ton auxiliary hoist is provided.

Steam Equipment.

Steam is supplied at 125 lb. pressure and 125 degrees superheat from eight Stirling boilers equipped with Babcock-Wilcox U-tube superheaters. Each boiler has a heating surface of 7,775 sq. ft. and the four batteries of two each are capable of evaporating 240,000 lbs. of steam per hour from and at 212 degrees Fahrenheit.

Fuel oil is drawn from two auxiliary tanks fitted with live steam heater coils and each having a sufficient capacity for a 24 hour run with two units. These in turn are to be supplied from two 9,000 bbl. oil storage tanks placed near the railroad track. The oil is forced to the Hammel burners by two 7½ x 5 x 6 Worthington pumps, after it has been preheated to about 130 degrees in a 400 h. p. American feed-water

heater. A Moore patent automatic fuel oil regulating system provides central control of oil, steam and air supply for combustion purposes.

The two stacks are of reinforced concrete with octagonal base and circular section, 150 ft. high with 15 ft. 4 in. base and 12 ft. 6 in. top diameter. A fire brick lining extends 60 ft. above the level of the boiler floor. The base of one stack is fitted as a lavatory with showers and lockers, the other being used as a storeroom. Two concrete smoke flues enter the stack from either side. These flues are 6½ ft. wide with trapezoidal sections 5 ft. 6 in. at the smaller end and 12 ft. 6 in. at the stack discharge. They are provided with expansion joints and clean-out doors.

The boiler feed water supply is maintained by two compound duplex Snow pumps 12 and 18 x 10 x 18, a 7,000 h.p. Cochrane feed water heater being provided.

A noteworthy feature of the equipment is the several measuring devices employed. These include two Worthington water weighers, the larger for weighing the condensate, being equipped with a special tank used as a hot well, and the smaller being used to weigh the make-up water which is obtained from a well on the property. General Electric steam and water flow meters are also employed.

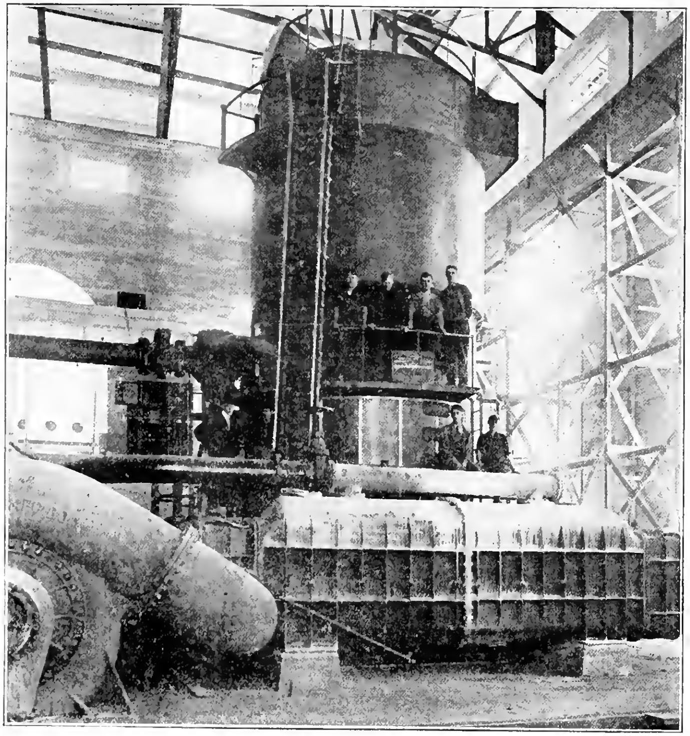

Fig. 1. 15,000 k.v.a. Turbo-Generator with Condenser Base.

The high pressure piping is all equipped with Van Stone joints, corrugated steel gaskets and forged steel flanges. The fittings are of cast steel and 85 per cent magnesia covering is used throughout. The main header is equipped with electrically welded nozzles leading to the auxiliaries. In the 250 ft. length of the 14 in. main header there are no expansion joints or loops, all expansion being taken up in flexible leads to the boilers.

The low pressure piping, including the main exhaust, auxiliary exhaust, circulating water, vacuum and hot well suction and discharge, etc., are of standard construction and are carried in the basement

The turbo-generator is an eight pole General Electric type ATB alternator driven at 750 r. p. m. by a vertical Curtis turbine with condenser base. Three phase current is generated at 50 cycles, 11,000 volts, the generator being rated at 15,000 kilovolt amperes.

Excitation current is furnished from two 125 4-pole General Electric 125 volt dynamos, driven at 2,400 r. p. m. by horizontal Curtis turbines operated non-condensing. Oil for the step bearings is supplied at a pressure of 1,000 lb. per sq. in. by two Dean Bros. oil pumps, 12 x 2⅞ x 12.

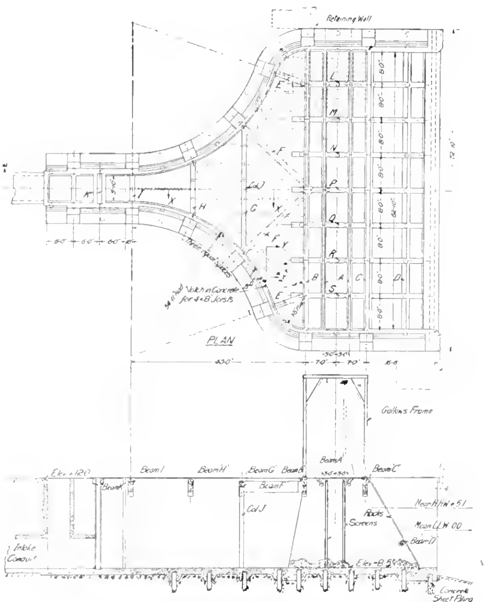

Fig. 5. Plan and Section of Intake.

Condensing water is brought from the Inner Harbor channel through an intake fitted with inclined racks and eight sets of duplicate screens, 56 inches by

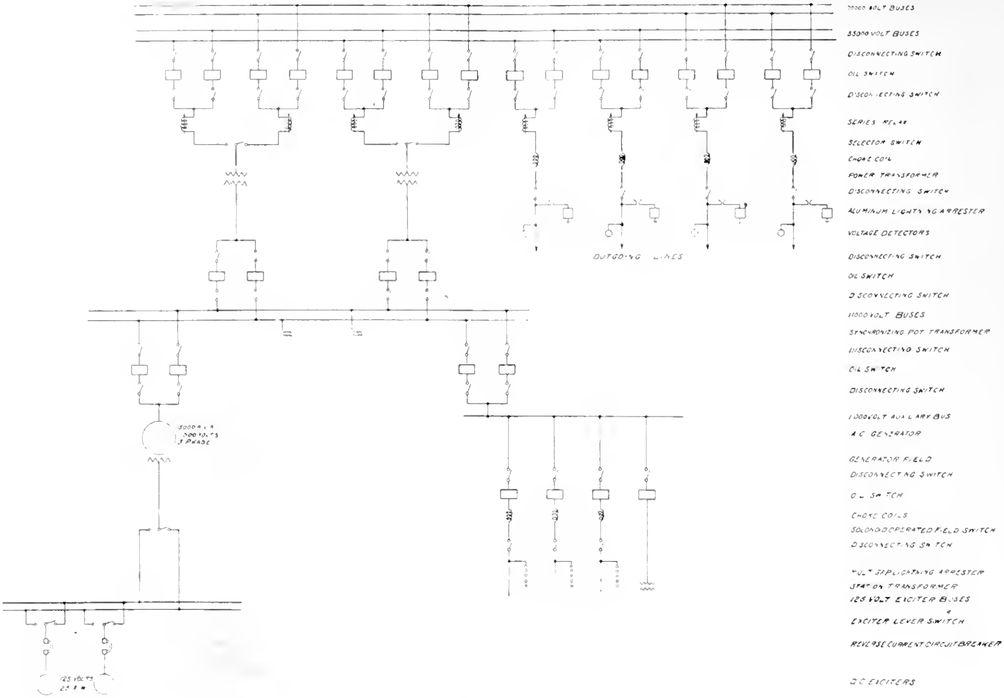

Fig. 6. Single Line Wiring Diagram.

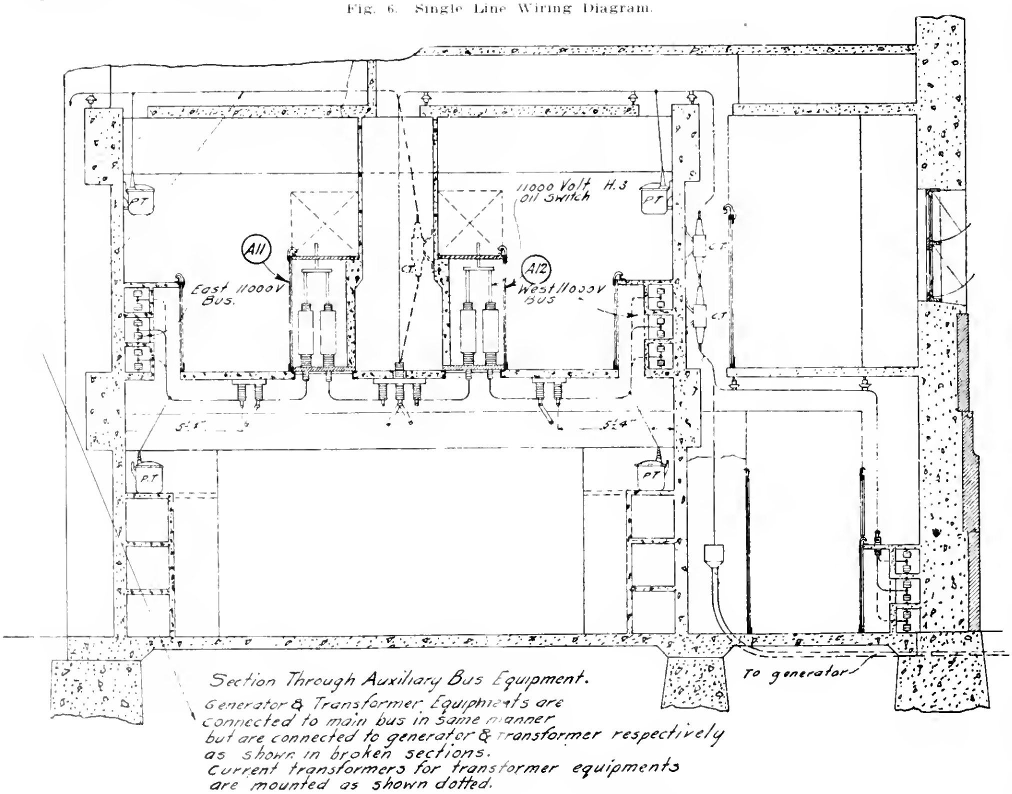

Fig. 7. Section Through Auxiliary Bus Equipment.

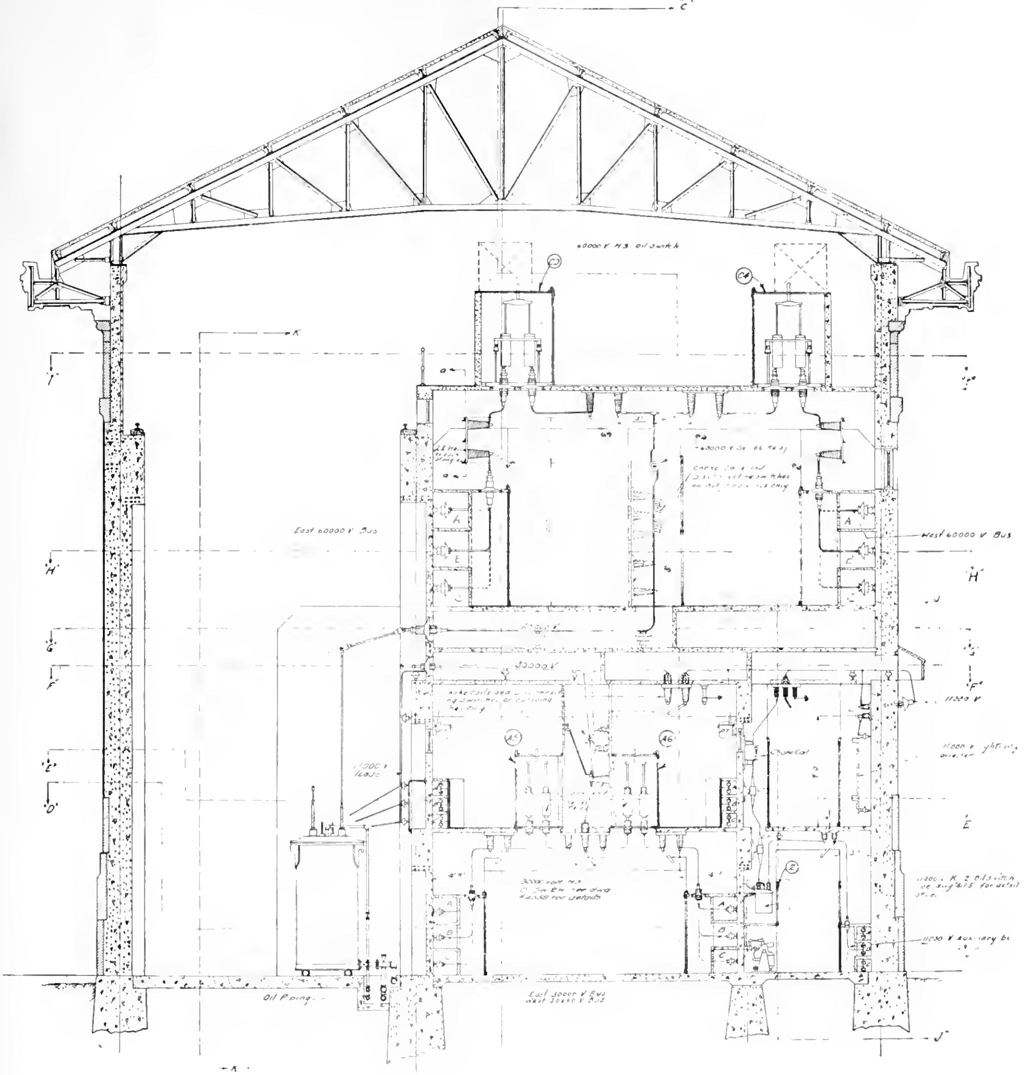

Fig. 8. Transverse Section Through Transformer House.

8½ ft. The screens are of 1 in. and ½ in. mesh respectively and are placed 6 ft. apart. Gallows frames are provided so that they may be hoisted from their grooves and cleaned. The intake conduit is of reinforced concrete with horseshoe section, being 6½ ft. high and 5½ ft. wide. Its top is 2 ft. below the level of low tide. This conduit extends under the transformer house to the generator room.

Here a 30 inch double suction Krogh centrifugal pump, driven at 240 r. p. m. by a 14 x 18 Harrisburg single cylinder engine, supplies 24,000 gallons per minute against a 35 ft. head to the main and auxiliary condensers.

The main condenser in the turbine base is a Wheeler dry tube type having 16,000 sq. ft. of cooling surface, the auxiliary having 5,500 sq. ft. The condensers are equipped with Volz heaters, the discharge from the 5 in. Wheeler centrifugal hot well pump being delivered to the upper tubes of the condenser.

Vacuum is maintained by a Wheeler rotative dry vacuum pump with 12 in. steam cylinder, 30 in. air cylinder and 18 in. stroke. A 36 in. Crane atmospheric relief valve is provided. The cooling water discharges through a 36 in. cast iron pipe into the reinforced concrete conduit leading to the channel, a syphon system being obtained between the intake and discharge conduits.

All of the equipment excepting the generator and other electrical equipment was furnished and installed by Chas. C. Moore & Co., engineers, of San Francisco.

The Electrical Equipment.

The electrical features of the Long Beach plant involve a number of novel points, most noteworthy being the fact that all the busbar and switching construction has been performed by an outside firm of specialists, the company's engineers exercising only a general supervision. The advantages of this method are obvious, as a company making a specialty of such installations, can thus relieve the operating company of much tedious detail.

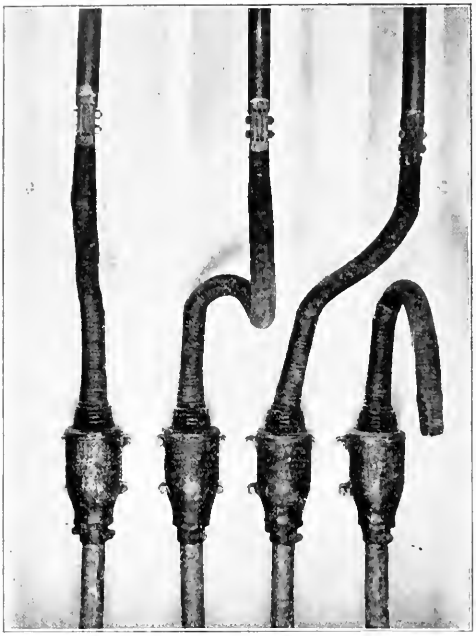

Fig. 9. Interchangeable Flexible Generator Lead Connections.

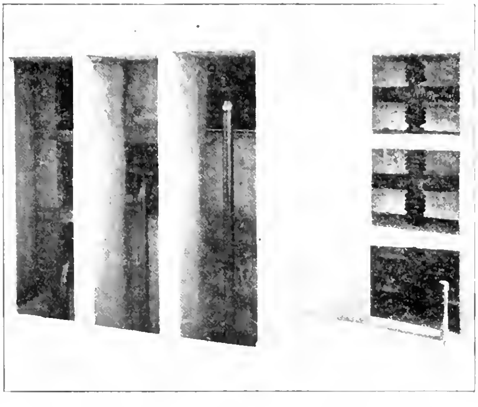

Fig. 10. Transformer Tap of 11,000 Volt Generator Bus.

The general scheme is best shown by the accompanying single line wiring diagram. As the details of the generators and exciters have already been given and as the switchboard is of standard construction and equipment, particular emphasis will be laid upon the transformer house construction.

The power house switch control consists of bench board and two vertical boards with the usual instrument equipment. The generator field switches are solenoid operated and asbestos covered wire is used throughout. A consistent color scheme has been adopted as follows: blue covered wire is used for the upper elements of meters and red for the lower, black is used for grounds, black and white for positive and negative operating buses respectively, and red and green for circuit closing and opening switches, corresponding to the red and green lights on the board. The switchboard gallery has a double floor and all cables and conduits are carried in trenches covered by movable floor plates, thus at once being easily accessible and yet out of the way.

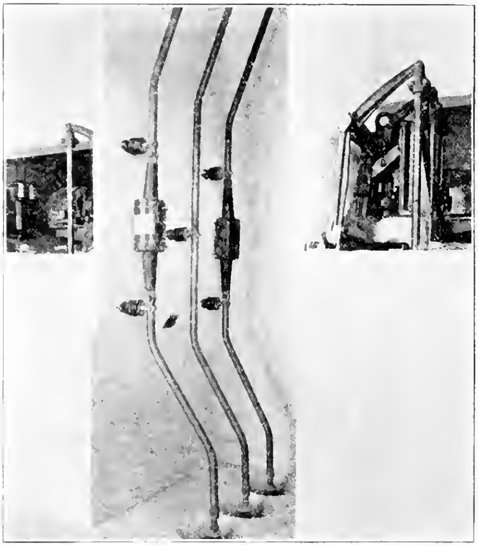

Fig. 11. Method of Supporting Current Transformer.

The generator leads are 1½-million circular mil cable with 11-16 in. fibre core. The four cables one of which is a spare are carried from the terminal board of the generator frame through brass tubing to the floor, whence by means of a basement trench they are carried in Orangeburg fibre conduit to the transformer house. Three reactance coils are placed in series with these leads so as to limit short circuit currents, each being rated at 50 cycle, 300 k. v. a., 381 volts, 788 amperes.

These four leads terminate in cable and bells whence flexible interchangeable connection can be made to the three generator tube conductors in the transformer house, as shown in the accompanying illustration.

Copper tubing is used throughout this entire installation instead of the more usual bar conductors, as it has a larger radiating surface and greater conducting area. It is also more rigid and able to withstand magnetic attraction between adjacent buses in case of heavy short circuit currents.

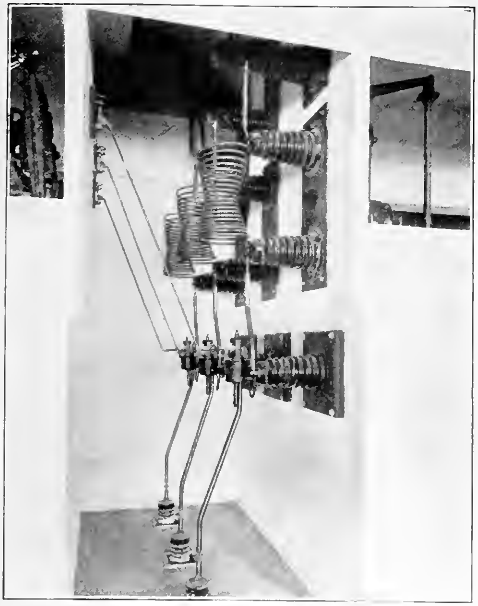

Fig. 12. Series Relay.

The generator conductors are of 2 in. extra heavy copper tubing, iron pipe size, carried vertically on standard round bus-bar supports through General Electric current transformers and double throw dis-

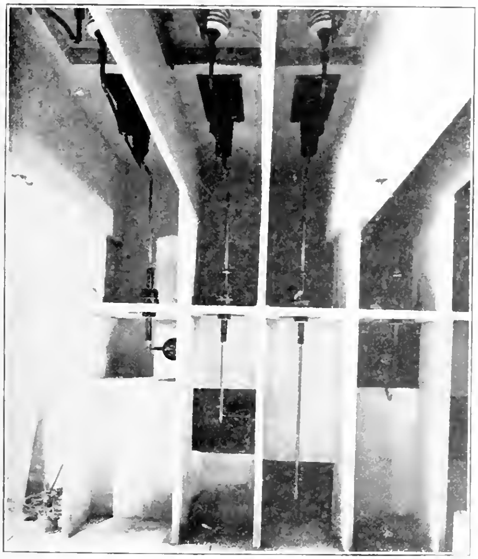

Fig. 13. High-Tension Bus Construction.

connecting switches to the 800 ampere H-3 oil switches and thence to the generator buses.

A novel method of mounting the current transformers is consistently maintained throughout the building. These transformers are ordinarily fitted with supporting feet to be attached to the wall. These feet have been removed and the transformer mounted as an integral part of the line as shown in the accompanying illustration.

The two generator buses are of extra heavy $2\frac{1}{2}$ in. copper tubing and extends the length of the building, being carried in 14 in. square compartments with 16 in. centers on bus-bar insulator double supports. These compartments are 2 in. thick and consist of concrete reinforced with metal lath.

Power at 11,000 volts is taken from the buses to the transformers in the reverse order, as shown by the dotted line in the accompanying drawing of the section through the auxiliary bus equipment. Current likewise is taken from the generator buses to the auxiliary buses on the first floor on the west side of the building. Thence the three 11,000 volt lines are brought through disconnecting switches and K-12 solenoid operated oil switches for distribution to near-by consumers and for station use. These 11,000 volt out-going lines are pro-

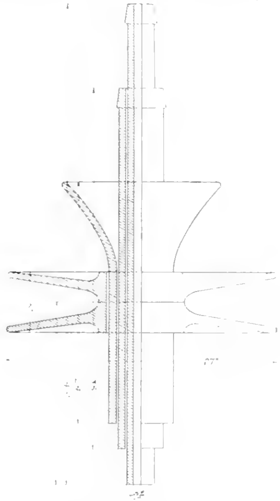

Fig. 14. Special Outside Service Wall Bushing for 80,000 Volt Delta.

tected by multiplex lightning arrestors and overhanging hoods. The method of supporting the generator buses and the transformer taps is well shown in the accompanying view.

The type FO, form A, 50 cycle, 2,000 kw. transformers step up the voltage from 11,000 to either 30,000 or 60,000 transmission potential according to the voltage of the transmission system into which this plant is feeding. They are arranged in two banks of three, one spare also being provided. They are delta-connected on the low tension side and Y-connected on the high tension side.

Conductors from the transformers are $1\frac{1}{4}$ in. copper tubing passing through a series relay, thence to a double throw disconnecting switch and H-3 oil switches to the 30,000 volt buses which are carried on the high tension insulator supports as illustrated. Power is taken from the buses in reverse order. The arrangements for the 60,000 volt lines are the same ex-

cept that the buses are of 1 in. copper tubing. On account of its stiffness and because of the absence of other support for the series relay, $1\frac{1}{4}$ in. tubing is used for this purpose. The high voltage lines leave the building through a service bushing. The details of which are shown in the accompanying sketch.

Both the 30,000 and 60,000 voltages are protected by aluminum cell lightning arrestors mounted on steel frame outside of the building. All the oil switches in this installation were manufactured by the General Electric Co. The fittings, bus-bar supports, etc. were furnished by the Electrical Engineers Equipment Co. and installed by J. C. Farrar & Co. of Los Angeles, their Western representatives.

This great plant stands as evidence of the foresight and ability of the vice-president and general manager of the Southern California Edison Co., W. A. Brackenbridge, under whose personal supervision it has been constructed. F. A. Sargent of Chicago was

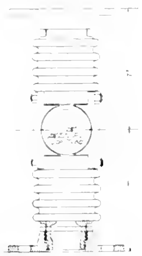

Fig. 15. Double Support Bus-Bar Separator.

consulting engineer, James A. Lighthipe, electrical engineer, had charge of the electrical installation, H. W. Dennis, was construction engineer, E. H. Warner, resident engineer, and H. L. Doolittle, chief engineer. The writer is especially indebted to the latter gentleman for the information in this article and to G. H. Bishop, the company's official photographer, for the pictures that illustrate it.

TABULATION OF ENGINEERING DETAILS.

First Unit of Long Beach Plant of Southern California Edison Company.

Generator	General Electric 15 000 k.v.a., 50 cycle, 11,000 volts.
Prime Mover	Vertical Curtis Turbine.
Boilers	Eight Stirling Water Tube, 7775 sq ft. heating surface each, 225 lb. pressure, 125 degrees superheat.
Superheater	B. & W. U. type, 125 degrees superheat.
High Pressure Pipe	Van Stone Joints—Cast Steel Fittings and Valves—Welded Nozzles.
Fuel	Crude Oil in Hammel Burners, with Moore Automatic Regulating System.
Stack	Reinforced Concrete, 150 ft. high, 12 ft. 6 in. top diameter.
Exciter	Four Pole, G. E., 125 volt, 125 kw., driven by Horizontal Curtis Turbine.
Circulating Pump	30 in. Krogh Centrifugal, driven by 14 x 18 Harrisburg Engine.
Condensers	16,000 sq ft Wheeler Dry Tube in turbine base. 5,500 sq ft Wheeler Dry Tube Auxiliary.

TRANSMISSION.

Voltage	30,000 and 60,000.
Transformers	Six G. E. 2000 kw. each, Y and delta-connected.
Bus-Bar	Extra Heavy Copper Tubing $2\frac{1}{2}$ in. for 11,000 volt, $1\frac{1}{4}$ in. for 30,000 volt and 1 in. for 60,000 volt.
[illegible]	Type H-3 and K-12.
Lightning Protectors	Aluminum Cell Arresters for 30,000 v. and 60,000 v. Multiplex Arresters for 11,000 v.

PRIMER OF APPLIED THERMODYNAMICS.[1]
NINTH LECTURE.

Chimney Draft and Design.

In previous lectures we have found that fuels give up their latent heat when brought in contact with oxygen in such a way that combustion takes place. The resulting chemical reactions must be gotten rid of in order to keep a fresh supply of oxygen for continuing the generation of heat and thus maintaining a continuous operation of the power plant. It is evident then that the chimney which performs this function must not only have height in order to produce the necessary draft, but it must also have width, or rather cross-sectional area, sufficient to carry the volume of gas necessary in combustion. We shall find in the course of this lecture that the draft of a chimney is computed theoretically by figuring the weight of a column of heated gas in the chimney and a weight of a similar column of air without. Since the heated gas within is lighter than the cooler air without, although at the

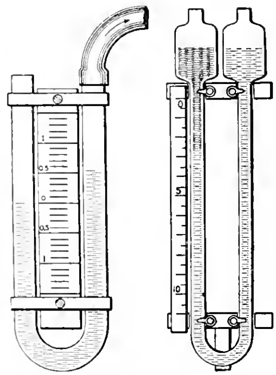

Fig. Barrus Simple and Compound Chimney Draft Gauges.

same temperature, due to ingredients of combustion being added, the condition would be reversed, the difference between these two weights will give us the theoretical draft or tendency of the cooler heavier air to drive up the chimney the heated gases of combustion. A practical measurement of this draft can be ascertained by closing the ash box doors and inserting a so-called draft or water column immediately in the rear of the combustion chamber at the lower end of the stack. Such a draft or water column is shown in Fig. 21. The heavier air without forces the column of water upward so that the weight of water level difference added to the weight of the gas within will just balance the weight of the air without. In practice this draft measurement is given in inches of water. In order to convert this into lb. per sq. in. it is necessary to multiply the draft in inches of water by the weight of a cubic inch of water which is 0.036.

Let us now derive the thermodynamic equations necessary for a theoretic discussion of mechanical draft. In a previous lecture we found that pressure,

[1]A resume', devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

volume, and temperature in a perfect gas such as air, were related to each other in such a manner that the product of pressure and volume was always equal to the product of a constant and the absolute temperature of the gas, or in mathematical symbols,

$$p\,v = R\,T, \text{ which for air is } p\,v = 53.37\ T.$$

We also found that the weight of a gas could be computed from the formula

$$W = \frac{p\,V}{R\,T}$$

and that the quantity R for any perfect gas other than air could be computed, as it is inversely proportional to the densities of the two gases. In the case of combustion every lb. of fuel requires—say n lb. of air to form (n + 1) lb. of chimney gases. Hence

R for the chimney gases is $\left(\frac{n}{n+1}\right)$ times the R for air.

Hence the weight of a column of chimney gas 1 sq. ft. in cross-section and H ft. in height is

$$W_2 = \frac{p\,H}{53.37\left(\frac{n}{n+1}\right)T_2}$$

And the weight of an equal column of air without which is to force the hot gas up the chimney is

$$W_1 = \frac{p\,H}{53.37\ T_1}$$

Where p is atmospheric pressure in lbs. per sq. ft., H the height of the chimney, T_2 the absolute temperature of the chimney gases, and T_1 the absolute temperature of the air without. Therefore the draft in the chimney, or

$$\text{difference of pressure per sq. ft.} = \frac{p\,H}{53.37\ T_1} - \frac{p\,H}{53.37\left(\frac{n}{n+1}\right)T_2}$$

$$= \frac{p\,H}{53.37}\left(\frac{1}{T_1} - \frac{1}{\left(\frac{n}{n+1}\right)T_2}\right)$$

Hence the draft in inches of water is computed by reducing the pressure first to lb. per sq. in. and then multiplying by the factor 0.036 given above.

$$\text{Draft in inches of water} = \frac{p\,H \times 144 \times 12}{53.37 \times 62.3}\left(\frac{1}{T_1} - \frac{1}{\left(\frac{n}{n+1}\right)T_2}\right)$$

$$D = 0.52\ H\ P\left(\frac{1}{T_1} - \frac{1}{\left(\frac{n}{n+1}\right)T_2}\right)$$

By a close examination, it will be seen for practical purposes, since the quantity n is from 18 to 50, in practice the fraction $\frac{n}{n+1}$ may be considered unity without appreciable errors. The atmospheric temperature is usually 60° F. and that of the chimney gases 500° F., atmospheric pressure 14.7 lb. per sq. in. For a chimney 100 ft. high then, we would compute the draft as follows,

$$D = 0.52 \times 100 \times 14.7\left(\frac{1}{459.4 + 60} - \frac{1}{459.4 + 500}\right)$$

$$= 0.67 \text{ ins. of water.}$$

Since this draft is computed for a stack 100 ft. high, the draft for any other height follows by an easy proportion.

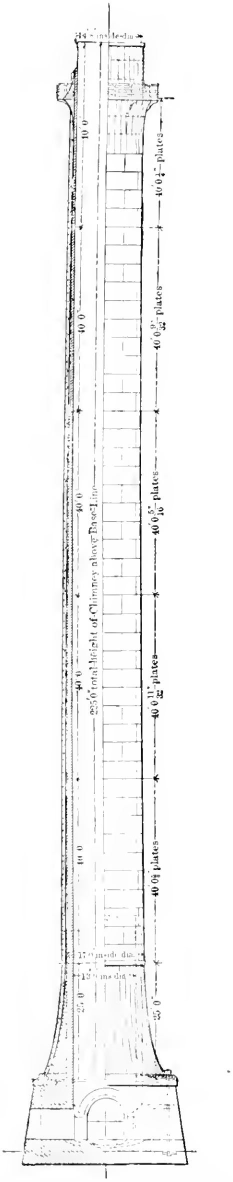

Fig. 22. Type of Chimney Design Favored by Babcock & Wilcox Engineers.

Experience shows that the draft pressure, measured in inches of water as compared with atmospheric pressure, should be from 0.5 to 1.5 inches, depending upon the character and size of the fuel to be used, and upon the quantity to be burned per square foot of grate surface. Heights above the grate, which have given satisfactory results in practice with plants of moder-

ate capacity employing different fuels, are given in the following table:

Fuel.	Height in feet
Crude Petroleum	80 to 100
Free-burning bituminous	80
Anthracite, large sizes	100
Slow-burning bituminous	120
Anthracite buckwheat	150
Anthracite slack	175

On the Pacific Coast crude petroleum is largely used as fuel. In coal burning, anywhere from 35 to 70 per cent of the total draft head is required to overcome the friction of the fuel bed. Now chimney tables are computed for coal burning on the basis of 5 lb. of fuel per boiler horsepower. In the case of oil burning, if we compute on the basis of 2½ lb. per boiler horsepower and consider that oil can be burned with a smaller excess of air than coal, we have virtually 2 to 1.

Chimneys are constructed of steel, reinforced concrete, or masonry. Steel chimneys weigh less, cost less, require less space, expose less surface to the wind than other forms, and are more efficient because they are air tight. They, however, depreciate more rapidly because of rust, and because of the corrosive influence of the flue gases.

We shall next consider the necessary corrections to be made in the dimensions of proposed chimneys in their relation to altitude above the sea. All chimney dimensions and tables have been computed on the basis of sea-level pressures. From our equation of draft readings derived in this lecture, it is seen that the draft depends directly upon the pressure. Hence it is evident that since the higher the altitude, the less the pressure, the stack must be lengthened in proportion to the barometric readings.

Size of Chimneys for Steam-boilers.

Formula, H.P. $= 3.33\,(A - 0.6\sqrt{A})\sqrt{H}$. (Assuming 1 H.P. = 5 lbs. of coal burned per hour.)

Diam. inches	Area A sq. ft.	Effective Area. $E = A - 0.6\sqrt{A}$ sq. ft.	Height of Chimney. 50 ft	60 ft	70 ft.	80 ft.	90 ft.	100 ft	110 ft	125 ft	150 ft	175 ft	200 ft	225 ft	250 ft.	300 ft.	Equivalent Square Chimney. Side of Square $\sqrt{E} + 4$ ins.
			Commercial Horse-power of Boiler.														
18	1.77	0.97	23	25	27	29											16
21	2.41	1.47	35	38	41	44											19
24	3.14	2.08	49	54	58	62	66										22
27	3.98	2.78	65	72	78	83	88										24
30	4.91	3.58	84	92	100	107	113	119									27
33	5.94	4.48		115	125	133	141	149	156								30
36	7.07	5.47		141	152	163	173	182	191	204							32
39	8.30	6.57			183	196	208	219	229	245	268						35
42	9.62	7.76			216	231	245	258	271	289	316	342					38
48	12.57	10.44				311	330	348	365	389	426	460	492				43
54	15.90	13.51					427	449	472	503	551	595	636	675			48
60	19.64	16.98					536	565	593	632	692	748	800	848	894		54
66	23.76	20.83						694	728	776	849	918	981	1040	1097	1201	59
72	28.27	25.08						835	876	934	1023	1105	1181	1253	1320	1447	64
78	33.18	29.73						...	1038	1107	1212	1310	1400	1485	1565	1715	70
84	38.48	34.76						...	1214	1294	1418	1531	1637	1736	1830	2005	75
90	44.18	40.19								1496	1639	1770	1893	2008	2116	2318	80
96	50.27	46.01								1712	1876	2027	2167	2298	2423	2654	86
102	56.75	52.23								1944	2130	2300	2459	2609	2750	3012	91
108	63.62	58.83								2090	2399	2592	2771	2939	3098	3393	96
114	70.88	65.83									2685	2900	3100	3288	3466	3797	101
120	78.54	73.22									2986	3226	3448	3657	3855	4223	107
132	95.03	89.18									3637	3929	4200	4455	4696	5144	117
144	113.10	106.72									4352	4701	5026	5331	5618	6155	128

and the stack area would be sufficient for double the horsepower. In designing stacks for crude petroleum, it can be taken as standard practice that fifty per cent of stack areas of Kent's tables given above are ample for fuel oil.

The ascending gases in a chimney are retarded by friction in the vicinity of the walls, and the equivalent cross section A of a round chimney is, therefore, generally taken as that corresponding to a diameter four inches less than the real internal diameter of the chimney. Professor Samuel Sheldon states that, assuming a coal consumption of five lb. per horsepower hour, a chimney of height h feet, properly to carry off the gases from boilers of P horsepower, should have an equivalent cross section of

$$A = \frac{0.3\ P}{\sqrt{h}}\ \text{square feet.}$$

William Kent has worked out formulas for chimney design which are largely used in practice and are found in the following table. With the corrections noted above for rude oil petroleum, proper chimney areas for Pacific Coast practice in burning oil can be picked at once from this table.

Thus if H is the proper height of a chimney at sea-level or barometric pressure P_0, then H_1 the proper height at the altitude P_1 above sea-level is as follows:

$$\frac{H_1}{H} = \frac{P_0}{P_1}$$

or if r is a factor gotten by dividing the barometric reading at sea level by the baremetric reading at the proposed point of installation, $H_1 = r\,H$. The next point to consider is how the altitude will affect the cross-sectional area. At high altitudes the air becomes less dense, hence the area should be larger in order to pass the required weight of air needed in combustion of the fuel, for the same weight of air is needed for proper fuel combustion, no matter what the altitude may be.

In the flow of gases through pipes, it has been found that the weight passing any given section per minute is

$$W = K\left(\frac{p\,D\,d^5}{\left(1 + \frac{3.6}{d}\right)L}\right)^{1/2}$$

Where

K = a constant.
p = difference in pressure between two ends of pipe.
D = density.
d = diameter of pipe.
L = length of pipe.

In applying this formula to gases flowing up a stack, the quantity $(1 + \frac{3.6}{d})$ is practically unity, the quantity L becomes equal to H and H_1 in the respective cases, and p is the same in each case. Hence we have

$$W = K \left(\frac{p D d^5}{H}\right)^{1/2} \text{ and } W_1 = K \left(\frac{p D_1 d_1^5}{H_1}\right)^{1/2}$$

But W must equal W_1 for fuel burning. Hence

$$K \left(\frac{p D d^5}{H}\right)^{1/2} = K \left(\frac{p D_1 d_1^5}{H_1}\right)^{1/2}$$

Also

$$\frac{D}{D_1} = r, \text{ and } \frac{H_1}{H} = r;$$

Therefore, substituting and cancelling

$$\frac{D d^5}{H} = \frac{D_1 d_1^5}{H_1}$$

$$\frac{r D_1 d^5}{H} = \frac{D_1 d_1^5}{r H}$$

$$r^2 d^5 = d_1^5 \therefore d_1 = d\, r^{2/5}$$

Hence in the design of a chimney at any altitude, first pick out dimensions for sea-level. Having found the proper height and diameter for sea level, the new height and diameter are found by the following rule. The quantity r is determined by dividing the barometric reading at sea-level by the barometric reading at the point of installation. Then multiply the height by r and the diameter by $r^{2/5}$, and the resulting height and diameter will be correct for the new altitude.

Sometimes short chimneys are used in connection with mechanical draft apparatus, consisting of either an exhaust fan in the smoke flue or a mechanical or steam-jet blower underneath the grate bars. An induced draft is produced by the former, and a forced draft by the latter. The advisability of installing mechanical draft apparatus is dependent upon the results of an economical comparison with the saving resulting from the lessened necessary height of the chimney, or the saving acquired by installation of an economizer which reduces the temperature so low that the draft is naturally lessened.

THERMOTWISTERS.

1. A stack is 125 ft. high. The flue gases have a temperature of 475° F., and the outside air is at 60° F., atmospheric pressure being 14.7 lb. sq. in. How many inches of water will the draft gauge read?

2. It is desired to design a stack to burn anthracite buckwheat coal to accommodate 2000 boiler horsepower. What are the proper dimensions at sea-level?

3. The above power plant is located at an altitude of 5000 ft. above sea-level and crude petroleum is to be burned. What are the proper dimensions?

SOLUTION OF THERMOTWISTERS—SIXTH LECTURE.

1. In the test of the Parker boiler found elsewhere in these columns during a ten-hour run 180,240 lb. of water were evaporated from a feed water temperature of 123.4° F. to superheated steam at 561.2° F., the boiler pressure being 179.7 lb. per in. (gauge). What is the factor of evaporation?

The total heat of superheated steam is from page 333.

$$H = 1150.4 + 0.3745 \ (t - 212) - 0.00055 \ (t - 212)^2 + k \ (T - t)$$

From table on Mean Specific Heat, page 333, I find k = 0.55

From table on page 330, I find t = 379.°5 for 179.7 lb. (gange)

Heat of feed-water at 123.4° = 91.4

$$H = 1150.4 + 0.3745 \ (379.5 - 212) - 0.00055 \ (379.5 - 212)^2 + 0.55 \ (561.2 - 379.5) = 1150.4 + 62.8 - 15.4 + 100 = 1298.0$$

$$\text{Hence factor of evaporation} = \frac{1298 - h}{970.4} = \frac{1298 - 91.4}{970.4}$$

$$= 1.244. \quad \text{Ans.}$$

2. From the data given in problem 1, compute the horsepower rating of the boiler.

Since 180,240 lb. are evaporated in 10 hr. in 1 hr., boiler will evaporate 18,024 lb. Hence it will evaporate from and at 212° F.

$$18{,}024 \times 1.244 = 22{,}420 \text{ lb.}$$

$$\text{Hence H.P.} = \frac{22{,}420}{34.5} = 650. \quad \text{Ans.}$$

3. During the same test mentioned in problem 1, 14,093 lb. of oil were consumed. The oil has 0.6% water. The calorific value of the dry oil per lb. is 18,681 B.t.u. by analysis, show that the efficiency of the boiler was 83.13% under the test referred to.

14,093 lb. of oil containing 0.6% water is equal to 14,093 × 99.4

= 14,008 lb. dry oil.

Since 1 lb. = 18,681 B.t.u. by analysis.

Total heat given out by fuel is

$$\frac{14{,}008 \times 18{,}681}{10} = 26{,}160{,}000 \text{ B.t.u. per hr.}$$

Since from ex. 1 we find 18,024 lb. of water evaporated per hr., each lb representing (1298 — 91.4) B.t.u. Hence boiler efficiency is

$$\frac{18{,}024 \times 1206.6}{26{,}160{,}000} = 83.2\%. \quad \text{Ans.}$$

4. A pressure gauge reads 179.7 lb. per sq. in. What is the temperature of the saturated steam in the boiler. Compute by the empirical formula given above.

From page 333 we find

$$t = 200\, p^{1/6} - 101.$$

Substituting for pres. of 179.7 lb. gauge or 194.4 abs., we have

$$t = 200 \ (194.4)^{1/6} - 101$$

$$1/6 \log 194.4 = 1/6 \text{ of } 2.288696 = 0.381282$$

$$\therefore (194.4)^{\frac{1}{6}} = 2.406$$

$$t = 200 \times 2.406 - 101 = 481.2 - 101 = 380.2. \quad \text{Ans.}$$

From Steam Tables t = 379.5.

INTERURBAN ELECTRIC LINES IN SPAIN.

Great activity is also shown at present in Spain in electric railway construction. The first part of the interurban line from San Sebastian to Tolosa (Guipuzcoa), consisting of the section from San Sebastian, via Anorga, Lazarte, and Oria, to Andoain, was recently opened, the cars running the nine miles in about 45 minutes. The power equipment at Andoain consists of a motor and dynamo of 260 horsepower, and maintains a continuous current of 600 volts to the terminus of the line at Venta Berri. The power is supplied by the Hidroelectric Iberica from waterfalls at Leizaran. Work is being rushed on the remainder of the line to Tolosa and it will be ready at the end of the year.

Work will soon be begun on the proposed line from Renteria to the French frontier, and the San Sebastian-Pasajes-Renteria line will construct a branch to Venta Berri. When these lines are thus connected a through service from Tolosa to the frontier will be established. Another line from San Sebastian to Irun, via Loyola and Pasajes, will soon be opened. A concession for the construction of a 10-mile electric railway from Parrino to Vigo, Province of Pontevedra, has been awarded to the Sociedad Iberia Concessions de Bilbao, of Bilbao. Two concessions for extensions of the Barcelona street railways and one for the Madrid city lines have also been recently awarded.

NAVIGATION THROUGH THE SUEZ CANAL.

Statistics regarding navigation through the Suez Canal are of intense interest to Pacific Coast enterprise at present due to agitation in the fixing of rates for the Panama Canal. The following is compiled from official British statistics:

The total number of passengers carried through the Suez Canal in 1910 reached 233,978, as compared with 213,121 in 1909. Of the number carried last year, those classified as military totaled 76,854, while the civilians numbered 128,171, and the pilgrims, emigrants and convicts 28,953. The following table shows the volume of shipping through the canal by flag, number of vessels, and net tonnage, including merchant vessels, mail steamers, war ships, etc.:

	1909		1910	
Flag	Vessels.	Net tonnage.	Vessels.	Net tonnage.
United Kingdom	2,561	9,592,387	2,778	10,423,610
Germany	600	2,381,681	635	2,563,749
Netherlands	251	806,950	259	854,561
France	231	802,100	240	833,099
Austria-Hungary	148	519,772	191	642,826
Italy	90	207,958	87	218,322
Japan	76	357,613	72	350,937
Russia	74	221,748	103	288,165
United States	[1]30	105,793	[2]8	8,996
All other countries	178	417,525	160	397,633
Total	4,239	15,407,527	4,533	16,581,898

[1] Including 27 war ships, tonnage 103,324.
[2] Including 4 war ships, tonnage 5,851.

Of the total tonnage for 1910, that of merchant vessels totaled 11,816,945 tons, mail steamers 3,990,817 tons, war ships 112,846 tons, Government-chartered vessels 158,097, and vessels in ballast 503,193 tons.

PRODUCTION OF PIG IRON BY ELECTRICITY

Consular reports from Sweden give some interesting figures on the production of pig iron by electricity.

The manufacturers of the electric furnace used in the co-operative experiments at Trollhattan state that the number of kilowatt hours required for the production of 1 metric ton of pig iron is, of course, higher for the poorer than for the richer ores. The following approximate figures are given as an average (metric ton = 2,204.6 pounds): For reduction of ore of 60 per cent iron content, 2,100 to 2,200 kilowatt hours per metric ton; 55 per cent iron content, 2,200 to 2,300 kilowatt hours per ton; 50 per cent iron content, 2,350 to 2,450 kilowatt hours per ton.

The quality, by weight, of carbon electrodes consumed in the production of 1 ton of pig iron has been ascertained to be about 10 kilos gross (including the electrode butts, which can not be used), but 5.27 kilos net (kilo = 2.2 pounds). With the round electrodes, capable of being connected with a scarf joint, now used at Trollhattan, the gross consumption will probably be about 6 kilos.

The consumption of charcoal varies from 20 to 23 hectoliters (57 to 65 bushels) per ton of pig iron, the lower figure being for iron containing little carbon and the higher for gray iron. For coke, which may be used to the same advantage as charcoal, the consumption should be calculated at 320 to 360 kilos.

At a furnace of 2500 horsepower, 10 hours of labor are required per ton of pig iron, but if the furnace is larger, for instance 3500 horsepower, or if several furnaces are worked at the same time, the labor hours can be reduced to seven or eight. The furnace at Trollhattan has required about 5 per cent of the working time for repairs and stoppages for exchange of electrodes, etc. In newly built furnaces this can probably be reduced. The content of iron in the slag has varied from 1 to 5 per cent, which has corresponded to a loss of ¼ to 2 per cent of iron per ton of pig iron.

QUANTITY OF CRUDE OIL AND OF PRINCIPAL PRODUCTS.

The number of 42-gallon barrels of crude petroleum used, as reported in 1909, was 120,775,439, and in 1904, 66,982,862, an increase of 53,792,577 barrels, or 80 per cent.

The kinds of crude oil used in 1909 were distributed in very different proportions from those in 1904. This change has materially affected the relative quantities of the various products.

The number of 50-gallon barrels of illuminating oils produced was 38,468,494 in 1909 and 27,135,094 in 1904, an increase of 11,333,409 barrels, or 42 per cent; of fuel oils, 34,034,577 in 1909 and 7,209,428 in 1904, an increase of 26,825,149 barrels, or 372 per cent; of lubricating oils, 10,745,885 in 1909 and 6,298,-251 in 1904, an increase of 4,447,634 barrels, or 71 per cent; of lubricating and other greases, 138,302 in 1909 and 202,439 in 1904, a decrease of 64,137 barrels, or 32 per cent; of naphtha and gasoline, 11,903,159 in 1909 and 5,811,289 in 1904, an increase of 6,091,870 barrels, or 105 per cent; and of paraffin wax, 946,830 in 1909 and 794,068 in 1904, an increase of 152,762 barrels, or 19 per cent.

LATEST TRIUMPH OF ELECTRICITY.

The Electrical Engineer of London details an interesting account of the latest triumph of the electrical art among the far-off Brahmans. Famous Hindu pundets have sat in solemn conclave at Calcutta to determine whether the sanctity of the famous Temple of Kali would be imperilled by the introduction therein of electric light, and after numerous sessions, during which with scholarly thoroughness the whole question was debated from every point of view, pundets and priests have decided with complete unanimity that the ions will carry with them no contaminating influence. So Kali-Ma, oldest and most potent of goddesses in the Hindu Pantheon, will in future be worshipped in the light of the twentieth century, and the mysterious twilight in which she has dwelt for so many centuries will be dissipated by metal filament lamps.

AN EXPERIENCE WHICH PRODUCES A SMILE.

The following experience was related at the Pacific Coast Gas Association Oakland Convention:

A demand was made on the office of a gas company for the installation of a gas meter. The office requested the usual deposit of five dollars from the prospective consumer, who instantly refused the payment of same.

There appears to be a law that meters must be set on request, within a certain time. The company

was quite unwilling to open an account with this party unless some guarantee of payment was given, as he was known to be evasive and indifferent to collectors. The party had demanded a meter in writing, so it seemed up to the company. A prepayment meter was set. Then the party took up the question of payment in advance, and held that we could not collect until after the goods were delivered. It now looked like our party had it on us; but not quite, for the prepay was left connected and the company dropped in the first quarter, thus giving the party 25 cents worth of gas. Our party found no legal objection to this method of service.

NILE SUDD AS FUEL.

As a result of the experiments which have been carried on in Europe and the Sudan during the last three or four years, says the Egyptian Gazette, the Sudan Government has definitely granted a concession, conferring a monopoly for the manufacture of solid fuel from sudd for 17 years. The government is to receive 10 per cent rebate on all fuel supplied at the price charged to public consumers. The government is further to receive a dead rent of $1,250 pr annum, or a commission of 5 per cent on the net profits of the company, whichever shall be the greater. The government has allocated to the concessionaires the first 150 kilometers (93 miles) of the Bthr el Gebel, starting from Lake No, in which they are to have the sole right of cutting papyrus, um-soof, and other aquatic growth constituting what is commonly known as sudd. The government further gives a site of 25 acres for the purpose of erecting a factory, etc., in any place which may be selected by the concessionaires, where such land may be available. The concession provides that the concessionaires shall supply the needs of all government services in preference to private consumers, and stipulates for a minimum output of 25,000 tons per annum. It is understood that the plant to be put down is to have an output of double that amount.

WORK OF RECLAMATION SERVICE.

Progress has been rapid and the activities of the bureau have been extended to 28 projects, which to date involve the expenditure of approximately $59,580,000 in the United States proper.

In the eight years of its work the service has built 5967 miles of canals, many of which carry whole rivers. It has excavated 19 miles of tunnels and built 24,235 canal structures and 2,193 bridges. It has completed three of the highest dams in the world. Its excavations of rock and earth amount to the enormous total of 73,666,000 cubic yards. Its roads have a total length of 570 miles; telephones, 1,694 miles; levees, 75 miles. It has purchased 905,682 barrels of cement and has manufactured in its own mill 340,000 barrels.

As a result of its work water is available for 1,086,000 acres of land. The gross value of crops produced on the lands irrigated by the Government projects in 1910 was $20,000,000. As a result of the work of the Government it is estimated that land values have increased more than $105,800,000.

Approximately 14,000 families are now residing on farms which are being watered by the Government canals. Not less than 25,000 people have been added to the population of the cities, towns, and villages as a direct result of the Government work.

COMPRESSED AIR IN MINES OF BUTTE..

According to facts recently published, the copper mines of Butte, Montana, are to-day producing copper cheaper than at any time in their history. This has been brought about by the introduction of many economies in operation.

Compressed air in the hoisting operations, electricity being the power employed, has made a material reduction in costs; while electric haulage underground and the substitution of electric power for steam in the operation of the pumps, has effected other savings. The saving effected in this way, as against steam, has been placed by local authorities at thirty-five per cent, some have placed it even higher.

ELECTRICAL ENTERPRISE IN ARGENTINA.

An engineer named Edwards has asked the Federal Senate to grant him a concession for constructing various cable railways in various parts of Argentina from Buenos Ayres to Rio Negro and from Patagones to Ente Rios. The concession is to comprise many subsidiary undertakings, including the generation and supply of electric power and the construction of grain elevators on the bank of the River Plata. The petitioner agrees to sign the contract for the construction of the work within six months from the date on which the law authorizing it is promulgated.

POWER RATES FOR PUMPING.

Word is received from Southern California that the Southern California Edison Company has revised its rates for pumping since the opening up of their new Long Beach plant. From midnight to 6:00 a. m. at the municipal pumping stations, the rate will be one cent per kilowatt hour; from 6:00 a. m. to 5:00 p. m. 1.33 cents per kilowatt-hour, this rate also being in force from 9:00 p. m. to midnight; from 5:00 p. m. to 9:00 p. m. two cents per kilowatt hour.

BIDS FOR MANILA GAS FRANCHISE.

Advertisements for bids for the gas franchise for the city of Manila were issued on September 16. Tenders will be received until December 18, 1911. A copy of the Philippine law providing for the granting of the gas franchise, as passed by the legislature at Manila, has been received by the Bureau of Manufactures, and will be loaned to interested firms. The franchise is for 50 years.

COMMERCIAL WOODS OF THE UNITED STATES.

The second series of this interesting group of investigations has just been published by the Forest Service. The bulletin, which is No. 99 of the U. S. Department of Agriculture covers the study of pines.

A WESTERN HIGH PRESSURE PLANT.

A hydroelectric plant which is to be constructed for the municipality of Penticton, B. C., will operate under a static head of 2115 feet, the effective head being computed as something over 2000 ft.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas" Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Where to Buy it in the West

Someone has said that old Jonah, as he was taking his aerial journey shoreward must have sarcastically remarked to the whale: "Well, old fellow, you can't keep a good man down." And so it is in the West with enterprise born or boosted on the Pacific Slope. The aggressive spirit there engendered cannot be downed.

A new country is made by the cooperation of its citizens. As the secondary coils of the transformer throb and breathe with the quivering life-giving energies that pulsate from the primary coils, so our industries—nay even our very material prosperity and happiness pulsate and throb with the nurture and nourishment of western spirit. "Hang together or hang separately," though a motto of the highwayman of vigilante days, has even a stronger, fuller meaning in the new era now before the West.

Some issues back the Journal started a listing in its columns of "Where to Buy It in the West." The listing is intended to detail the local houses throughout the West where various classifications of standard specialties may be obtained. The spontaneous and whole-souled support with which our efforts have been met is certainly indicative of the fact that the heart-string of the west has been reached in the satisfaction of a long felt want.

While engineers come and engineers go, and commissions still figure Depreciation we want at this time to expess our heartfelt Appreciation.

Power Plant Visitation

The larger manufacturing concerns with their power plants in educational centers, have of late fairly swarmed with engineering students from Western universities. The idea is a capital one. It gives the student an enlarged vision of the engineering world, clinches discussion taken up in the lecture room, and incidentally gives the power plant operator a taste of the student side of engineering life not the least part of which is the impression of amazement left in the operator's mind as to how one small human brain can contrive so many questions in so brief a period of time.

The question of visitation is important, however, not alone to the university student. The professional engineer who crawls into his shell day in and day out, neglecting to see the progress in design made by his competitors, is liable some day to be left behind in the onward progress of events, and though he may stoically declare, as does the lost Montana Flathead—"Injun no lost, tepee lost"— he will awaken some day to find that the world at large considers him in the class of yesterday.

The interesting part of engineering life is that ideas and designs, like fashions, are constantly changing. Mental and material junk, composed largely of the most brilliant ideas and design of yesterday, are today heaping high. The difference between the engineer and his brother laborer who pushes the truck back and forth in unloading the cargo, is that, while both find exquisite enjoyment in the "continual round of pleasure" involved, the round of pleasure of the

engineer does not necessitate such a literal interpretation, but daily—yes, even hourly—changes to new field of endeavor and experiences.

The Call of the Engineer

In the early classification of the various engineering professions, but two distinct branches were recognized, and the expert so engaged was known as either a military or civil engineer. In fact, going still further back into ancient history, we find only one classification, and usually the engineeer of ancient times was known simply as a mathematician. Hundreds of years before the Christian era, the city of Syracuse put up its stubborn defense covering years of siege by an obstinate enemy. Upon closer examination into the reasons as to how a city could withstand the long period of onslaught by apparently overwhelming odds, we find that it was due to the brains and design of that ancient giant mathematician, Archimedes, who playfully announced that he could, with his levers, move the whole universe if he could only find a place upon which he could rest them.

When, in spite of the powerful stone-hurling machines that he had invented, the enemy, after years of siege, finally in triumph entered the fallen city, Archimedes was found drawing his designs in the sand. Furthermore, history tells us that he wrathfully resented, perhaps in words bordering on modern forceful engineering vocabulary, the interference of a soldier, who interrupted the working out of these designs. We can imagine that every scornful, browbeating expression of the modern chief draftsman was made use of by this ancient designer in ordering the intruder not to "disturb his circles."

Be this as it may, the incident is instructive to those who are studying the progress of the engineering profession. This early idea that the engineer is first of all a mathematician, then a recluse designer, is on the verge of a transformation so complete, so revolutionary, that young engineers, entertaining a future career in their profession and dreaming along lines of former views of what a career leads to, had better explode a keg of dynamite and wake up, or theirs will be the field occupied by the hundred dollar-a-month men, and perhaps some day some apparently rough soldier brother, who has early recognized the higher plane to be attained in the profession, may come along, "disturb the circles," cut off his head, and put a more aggressive chap in the place so long occupied.

In a word, the call of the engineer for the future is broader than that of the mere mathematician, designer, or operator. Our entire country is awakening to new ideas of property rights and property interests. New ideas as to what are just and proper relations to be maintained between the great public service corporations on the one hand and the people on the other. New ideas as to how rates are to be made, appraisements computed, and even new ideas as to how the corporations should run their own business affairs. Throughout the ages the man who has been put in such a position that it is his function to deal out justice to his fellow men has been universally recognized as occupying the highest calling within the gift of his fellows. Such a calling is so high, so broad, and so humanitarian, no other profession is worthy to touch the hem of its garment.

California, Washington, Oregon, Utah and Nevada have recently passed several constitutional amendments, which put the very life and well-being of her public service corporations into the hands of the State Railroad Commissioners. It requires little stretch of imagination to come to the conclusion that in the not-far-distant future, practically every corporation, whether serving the public in the way of furnishing water, heat, electricity, transportation, or engaged in furnishing the great supplies of foodstuffs, such as coffee, sugar, flour, and the like will be under the rigid inspection and control of government commissions.

The question then arises as to who is to be the educated, fearless, justice-giving personage that is to deal out carefully balanced decrees to all sides of the impending controversies. The lawyer certainly can not do it, for while his high strung, sensitive instincts pick technicalities and refined meanings of man-made statutes as quickly as the armature of the motor responds to the current-enlivened magnetic field, he has at best only a limited knowledge of the laws that nature has made in the design of that magnetic field, and consequently can never with proper delicacy solve the commercial problems resulting from these laws. Again an accountant or auditor can not do it, for while his years of technical grinding into costs and systematic detailing and listing of every expense of maintenance and operation, hold the uninitiated spell-bound with the rapidity with which facts and figures can be handled, yet his ignorance of the great laws which go to build up the engineering industry deprive him of that delicacy in judgment required in weighing depreciation which comes alone to the engineer versed in the art through years of practice and study in his profession.

And so it is, the delicate task must be left solely to the engineer of the future. Our engineers will do well to early realize the high duties ahead. No half-baked ideas on depreciation can ever win for them the commendation of all concerned. Minerva, the goddess of Wisdom, is said to have sprung from the brain of Jupiter full-grown and full-armed, but ours must be a struggle of development. Let us, then, as engineers, put forth renewed effort to meet the high calling ahead for us, and in this educative effort, let us sprinkle a liberal seasoning of the golden rule idea, not as some would make it, "Do others, or others will do you," but rather let us learn to weigh our decisions from the inner recesses of the human heart, and the greatest triumph of any profession is in store for the new call of the engineer.

PERSONALS.

Henry L. Scott, president of the Pacific Telephone & Telegraph Company, is at New York.

A. Costas, an electrical engineer of Mill River, Oregon, visited Portland on a short business trip recently.

W. L. Goodwin, manager of the Pacific States Electric Company has returned to San Francisco from a business trip to Los Angeles.

F. A. Nash, president of the Omaha Electric Light & Power Company, is at San Francisco on a trip covering the Pacific Coast.

P. L. Thomson, formerly manager of the Western Electric Company's Pittsburg house, has been appointed advertising manager.

F. S. Hurst, sales engineer with Pierson, Roeding & Co., has returned to San Francisco, after a month's visit to Southern California.

Mortimer Fleishacker, the well-known banker and power magnate, is again at his Western headquarters after a recent business trip through the East.

H. Bostwick, secretary to the President of the Pacific Gas & Electric Company, has returned to San Francisco after a flying trip to Honolulu, T. H.

Thomas Mirk, of Hunt, Mirk & Co., has returned to San Francisco after visiting Southern California points in connection with new contracts secured.

H. V. Carter, president of the Pacific States Electric Company, has returned from a six-day excursion through the mining districts of Northern California

F. H. Poss, manager of the Pacific Coast department of the Holophane Company, has returned to San Francisco after a business trip to Los Angeles.

B. F. Kierulff, Jr., of Los Angeles, is visiting the Eastern factories of the several electrical manufacturers for whom his company is the Pacific Coast representative.

Homer McNutt, manager of the San Diego Electric Railway Co., has returned to San Diego from the American Electric Railway Association convention at Atlantic City.

Robert L. Jaynes, of Pittsburg, Pa., was elected Jupiter of the Rejuvenated Sons of Jove at the annual meeting at Denver, Colorado, at the time of the Denver Electric Show.

H. A. Lardner, manager of the Pacific Coast branch of J. G. White & Co., of New York, has returned to San Francisco after spending about two months on the Atlantic Coast.

H. D. Donnell, agent for the Safety Car Heating & Lighting Company, has returned to his San Francisco office after a trip to Portland, where he found business conditions active in his lines.

J. J. Youd, electrical engineer for the Mariposa Commercial & Mining Co.'s hydro-electric plant at Bagby, California, has just completed a $10,000 repair job on the company's dam at that place.

J. B. Ingersoll, formerly electrical engineer with the Spokane & Inland Empire Railroad Co., at Spokane, Wash., is now electrical engineer with the British Columbia Electric Co., at Vanvouver, B. C.

G. R. Murphy, manager of the storage battery department Pierson Roeding & Co., left for Philadelphia October 24th to attend the annual meeting of the district sales managers for the Electric Storage Battery Company.

P. M. Downing, engineer of operation and maintenance of the Pacific Gas & Electric Company, is making a visitation of the hydroelectric plants of the system, in company with J. H. Wise, the assistant general manager.

Robert Sibley, editor of the Journal of Electricity, Power and Gas, is attending the California Municipalities League meeting at Santa Barbara, after which he will make a short visit at Los Angeles before returning north.

James Irvine, formerly Pacific Coast representative of the Central Electric Co., of Chicago, has bought a large interest in the Lorbeer Electric Supply Co., of Los Angeles, and San Francisco, making his headquarters at Los Angeles.

John M. Moran, president of the Moran Engineering Company of Seattle, has returned after a three weeks' business and pleasure trip East. Mr. Moran's itinerary included Milwaukee, Chicago, Deming, Ohio, and New York City.

Franz Kammann, a hydraulic engineer from Austria, is examining various hydro-electric plants in the West. After going through the various plants of the Washington Water Power Co., at Spokane, he left for California by way of Portland.

H. F. Wheeler has resigned as superintendent of distribution for the Spokane Falls Gas Light Co., Spokane, Wash., to become general superintendent of the gas works at Hattisburg, Miss.

A. C. Sprout has returned to his San Francisco office for a short stay, after spending several months in Northern California for the Siskiyou Electric Power & Light Company, as electrical engineer in charge of the work on the Klamath River development.

B. E. Dudley, sales manager of the Chicago office of the Lombard Governor Company, for which Pierson Roeding & Co., are Pacific Coast agents, is at San Francisco in connection with the bids on the hydro-electric plant of the Los Angeles aqueduct project.

Sidney R. Inch, manager of the Missoula Light & Power Co., is again back superintending his Montana duties after an enjoyable 60-day rejuvination abroad. Mr. Inch has not been to England, his old home, for ten years, consequently the long-looked-for treat was enjoyed to the utmost.

Alexander McAdie, professor of the U. S. Weather Service for the Western division, has added one additional factor in aiding maritime progress on the coast by sending out weather forecasts each morning at nine o'clock by wireless, which reach vessels at sea within a radius of six hundred miles.

J. B. Birdsall, assistant to the general manager, and C. E. Lane, assistant to the chief draftsman of the Union Iron Works, were the courteous guides for the recent visitation of the Mechanical and Electrical Engineering students of the University of California at the company's works in San Francisco.

Delos A. Chappell, president of the Southern Sierra Power Company, has been spending some days at San Francisco on business connected with the early construction of a 250-mile steel tower line from Bishop to San Bernardino. Power will be transmitted from a new hydro-electric plant, and a steam relay station will also be installed at the latter city.

F. X. Cleary has resigned his position as advertising manager for the Western Electric Company, to engage in special advertising and sales promotion service. Mr. Cleary's long service as salesman, sales manager, and advertising manager has given him a wide experience and acquaintanceship in the electrical field, which will continue to be his line of future effort.

Bion J. Arnold has been formally retained by the Board of Supervisors of San Francisco to investigate the local street railway lines and render a comprehensive report on the traffic situation. Mr. Arnold will receive a retainer of $2500 and $250 a day while actually at work on the city's problems, including the relief of the street car congestion and the out-

lining of the city's future street railway development. The best method for the completion of the Geary street electric railway and the laying out of a comprehensive system of municipal lines for the future will also be considered.

George L. Davis, chief engineer of the Pacific Railway & Navigation Company of Portland, with Mrs. Davis, returned recently from California, where they spent more than two months. Mr. Davis, who went away on leave of absence because of illness, has recovered his health completely and has resumed his former position. While in California Mr. and Mrs. Davis visited San Diego, Los Angeles and San Francisco.

OBITUARY.

Robert Mather, chairman of the Board of Directors of the Westinghouse Electric & Mfg Co., died at his home at New York City, October 24. Mr. Mather visited San Francisco last September while on a tour of the Pacific Coast.

ELECTRICAL CONTRACTORS' NOTES.

Harry Tittle, manager of the John G. Sutton electrical department, arrived from Vancouver Sunday night.

The National Electric Company have been awarded a job of wiring for Mrs. Emma Ferris, on Market street, between Fifth and Sixth.

The Butte Engineering & Electrical Company have been awarded the electrical work for the Crocker Hotel on Mission street, between Third and Fourth.

Geo. Duffield, organizer for the National Electrical Contractors' Association, has spent the past ten days in San Francisco and the vicinity, talking to the contractors about National organization.

In speaking of the California Contractors' Association he says that it is well organized and ranks with New York and Illinois, which both have large organizations. Mr. Duffield leaves for the southern part of the State Friday morning.

In company with W. S. Hanbridge, State Secretary of the California Association of Electrical Contractors, Mr. Duffiield has visited San Jose, Palo Alto, Oakland, Santa Rosa, Sacramento and Stockton. He has obtained a great many new members for the National body and reports that a great deal of good work is being done in the East in getting lighting companies to cut out wiring at cost and also to better the contractors' conditions generally.

TRADE NOTES.

The Siskiyou Electric Power & Lighting Company, Yreka, Cal., has ordered from the General Electric Company three 200 kw. and two 500 kw. water cooled, and two 300 kw. oil cooled 60,000-volt transformers and a switchboard.

R. F. Oakes, president of the American Ever-Ready Battery Company, states that since additional machinery has been installed the capacity of the San Francisco factory has been increased to two carloads of batteries each day. Additional ground has been leased in the rear of the factory to provide increased floor space for manufacturing and warehouse purposes.

Hunt, Mirk & Co., who were recently awarded a contract for a complete electric power plant, to be operated with oil fuel, by the Tulare County Power Company, have just commenced work at the site of the brick power station, which will cover an area of 55x60 feet. Westinghouse-Parsons turbo generator equipment, with a capacity of 3000 horsepower, is to be installed at Tulare. This plant is to be completed next April and then a hydro-electric plant will be commenced. Artesian wells are being driven on the premises to furnish water for the water-tube boilers. F. T. Billings, who is interested in the company, estimates the total expenditure on steam plant and distributing system to reach $250,000.

MEETING NOTICE.

The correct date of the National Mine Safety Demonstration is October 30 and 31.

THE CALIFORNIA MUNICIPALITIES LEAGUE MEETING.

The following partial program of the California Municipalities League carried out during the past week at Santa Barbara is of interest to the engineering world and proved of much interest and profit to those hearing the papers and discussion.

Wednesday, October 25, 1911, 9 o'clock a. m., department of engineers, councilmen and street superintendents. "Municipal Lighting Plants," Prof. C. L. Cory, University of California. (Impromptu discussion by delegates). "Water Supplies for Small Cities," Prof. C. D. Marx, Stanford university, and president board of works of Palo Alto. (Impromptu discussion by delegates). "Purification of Water Supplies," Prof. Charles Gilman Hyde, University of California. (Impromptu discussion by delegates: "Conditions Affecting Municipal Water Plants in Central California," Frederick C. Roberts. (Impromptu discussion by delegates). Franchise Under the New Constitutional Amendment," Percy V. Long, city attorney of San Francisco. (Impromptu discussion by delegates).

Thursday, October 26, 1911, 9 o'clock a. m., department of engineers, councilmen and street superintendents. "The Importance of Proper Sewage Disposal, With a Reference to the Imihoff Tank," C. E. Grunsky, civil engineer of San Francisco. (Impromptu discussion by the delegates). "The Use of Vitrified Sewer Pipe," Prof. Fred H. Tibbetts. (Impromptu discussion by delegates). "The Use and Value of Corrugated Iron Culverts," Chris. P. Jensen, city engineer of Fresno. (Impromptu discussion by delegates). "Disposal of Refuse in San Francisco," F. K. Blue, assistant city engineer of San Francisco. (Impromptu discussion by delegates). "Garbage Incinerators for Small Cities," Charles E. Slian, city engineer of Mill Valley. (Impromptu discussion by delegates). "The Use of Asphaltic Base Oils for Roads and Streets," Charles A. Blackmar, oil inspector of Los Angeles. (Impromptu discussion by delegates). "Oil Macadam Pavements," George N. Randle, city engineer of Sacramento. (Impromptu discussion by delegates). "Substantial Pavements for Streets and Highways," R. M. Morton, engineer of the highway commission of San Joaquin county. (Impromptu discussion by delegates).

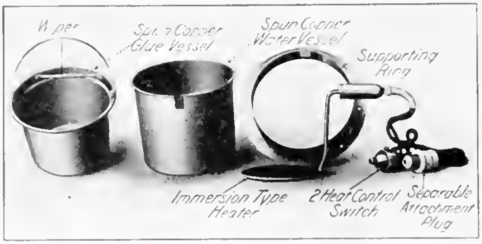
NEW TRADE PUBLICATION.

The Westinghouse Electric & Manufacturing Company has just issued the first edition of a small monthly publication entitled "Small Motors," which is devoted to forming a co-operative bond between the manufacturer and the dealer in small electric motors for general household, store, and office work. The publication is devoted to practical applications of small motors showing views of motors in actual service, such as operating ice cream freezers, small lathes, washing machines, grinding wheels, and numerous other household devices. An interesting application of the small motor for the household is its use as an auxiliary to the furnace, assisting the heating and ventilating of same. By means of a blower attachment the motor may be used.

INDUSTRIAL

ELECTRIC GLUE HEATING APPLIANCES.

It has been authoritatively stated that more than $4,000,000 is paid every year by manufacturers in this country for glue. It has also been asserted, by those in position to know, that approximately one-half of the glue purchased, or $2,000,000 worth, is wasted yearly. Some of this waste is unavoidable, but much of it can be prevented. A great deal of glue is spoiled through over-heating. It is well recognized that the proper temperature for melting glue lies somewhere in the neighborhood of 140 degrees Fahrenheit. It is also thoroughly appreciated that, if the temperature of glue is allowed to much exceed 160 degrees Fahrenheit, if it is not rendered wholly unfit for use, its strength will be greatly impaired. An expensive glue thus abused will be no more effective than a cheap one.



Exploded View of Flush Bench Type Glue Pot.

Either live or exhaust steam has a temperature (at atmospheric pressure) of at least 212 degrees Fahrenheit. This is altogether too high for glue heating.

Electrical methods of glue heating are, when properly applied, ideal. The east with which the heat can be controlled, the evenness of the temperature afforded, the readiness with which electricity for glue pot or heater operation can be conducted to any part of a factory, and its economy are all convincing recommendations for the electrically heated appliances.

Not all electrically heated appliances give satisfactory service. Some electrical glue pots are made without water baths and it has been found that these burn glue. In other glue pots the electrical heating element is arranged in the device in such a way that only a small portion of the heat generated is usefully expended in heating glue. The rest—a large proportion—is wasted by being radiated from the heater.

The Westinghouse Electric & Manufacturing Company is manufacturing a line of glue-heating appliances that have been designed to incorporate all desirable features.

CONVENIENT MEANS FOR DETERMINING FLUE GAS TEMPERATURES.

It is an interesting fact that the melting points of metals are found to be too uncertain and evasive to be used as temperature tests. That is, it is difficult to tell the exact point at which the metal melts, since it does not change suddenly from a hard solid to a liquid, as does water, but goes through an intermediate softening stage similar to iron and many other substances. Even after the metal is completely melted, a hard skin of oxide is usually found to have been formed upon its surface, which prevents the metal running easily, and therefore is apt to confuse the determination of the exact temperature.

The Green Fuel Economizer Co., therefore, devised the expedient of using the tensile strength of the metal, instead of the melting point, as the true indication of temperature. In other words, the pendants are made with a large body, having a certain definite weight, suspended from a narrow neck, and the composition of the metal and cross section of this neck are adjusted until the body of the pendant will pull the neck in two and fall at some desired temperature.

In actual use the pendants are hung upon a small hook made upon the end of a long wire which is introduced into the flue so that the pendant will be at the desired point. The best way is to begin with the lowest temperature pendant and proceed until the one is found which will not fall off after five or ten minutes' exposure. The temperature will then lie somewhere between the temperature marked on the last pendant and the next to the last pendant used. In doing this, it is quite essential that several different points in the flue be tried, as it very frequently happens that one part of the flue is occupied by gases much hotter than the gases in other parts of the flue.

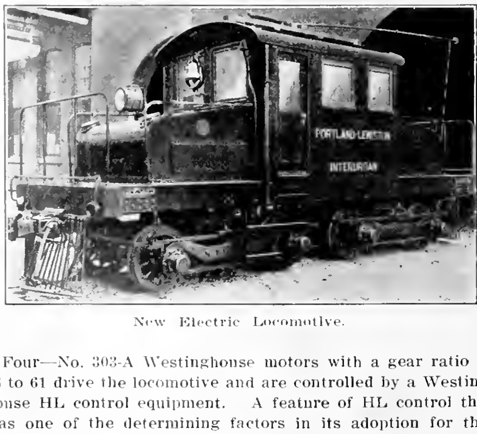
SEPTEMBER SALES INCREASE 12%—SEPTEMBER THIS YEAR BIGGEST SEPTEMBER IN COMPANY'S HISTORY.

Western Electric experienced a most satisfactory revival in orders billed out of its factories in September. After four months of comparative declines shipments came back last month with the best increase for many a month and the largest this fiscal year. The gain was 12% ,and September sales were the largest for that month in the company's history.

For the nine months to September 30 Western Electric gross was 4% in excess of the same period last year, and a total overturn for the full twelve months of $66,000,000 is promised.

PORTLAND, GREY & LEWISTON RAILWAY COMPANY'S ELECTRIC LOCOMOTIVE.

A Baldwin-Westinghouse electric locomotive was recently purchased by the Portland, Grey & Lewiston Railway Company. The locomotive is designed by the Baldwin Company as one of Class 8-4/100, E 9. This classification indicates that there are eight wheels total and four motors per locomotive. E is a classification letter used by the Baldwin works, donating the number of driving axles. One hundred stands for the horsepower of the motors, and the 9 means that it is the ninth locomotive built of its class.



New Electric Locomotive.

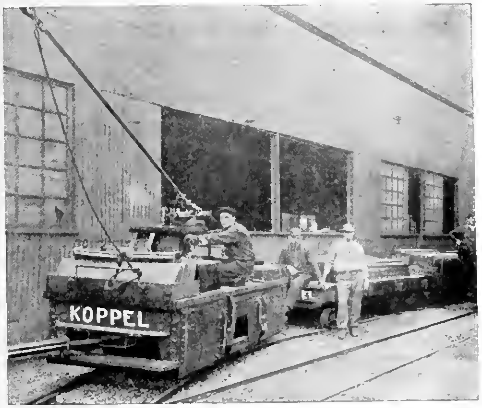
Four—No. 303-A Westinghouse motors with a gear ratio of 16 to 61 drive the locomotive and are controlled by a Westinghouse HL control equipment. A feature of HL control that was one of the determining factors in its adoption for this application is the incorporation of an ideal circuit-breaking

device in the control equipment. The line switch performs the functions of a circuitbreaker. The switch is controlled by a relay which operates whenever the current to the motors exceeds a predetermined value.

There are several breaks in series, and the arcing effect is distributed among them all, providing an effective breaking distance of several inches.

A STEEL MILL'S INDUSTRIAL RAILWAY.

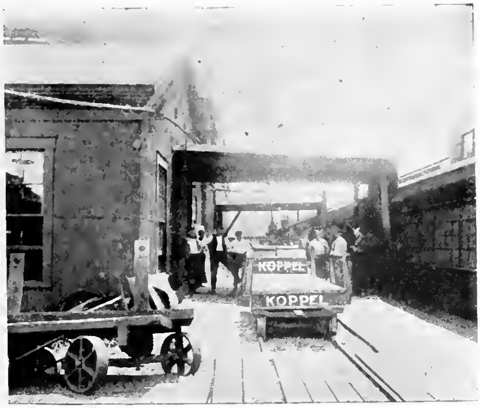
The quick and economical transportation of material has long been a serious problem in many steel plants. The managers of the mills of the Superior Steel Company, in Carnegie, Pa., alive to modern improvements, have most efficiently



Electric Transportation in a Steel Mill.

solved this problem. Only recently they have completed the installation of a new system of transporting their steel and raw materials from one building to another and around the mills.

Formerly this was done by means of the time-honored trucks run over steel plates laid on the floors about the mills and hauled by men. Today they have in successful operation



Modern Improvements in Mill Transportation.

a complete industrial railway system, including electric locomotives, cars, tracks, switches, etc., enabling them to quickly and easily haul materials to all parts of their plant.

This entire equipment was furnished by the Oranstein-Arthur Koppel Company, of Pittsburg, and was built in their own plant at Koppel, Pa. The electric locomotives shown in the accompanying illustrations, which give different views of the equipment in the Superior Steel Company plant, are operated by an overhead trolley, and are easily handled by one man. By the old method of hauling it required several men to handle each truck—today one man operates a whole train.

The steel company think so well of their Koppel equipment that they have just recently ordered twenty-four additional cars. These will soon be delivered and will give the steel company ample facilities for handling all their products.

A NEW ELECTRIC CIGAR LIGHTER.

Many interesting characteristics are displayed by the heating element used in the Helion cigar lighter, now being put on the market. It has many hundred times the resistance of platinum or of nickel chronium alloys. Consequently a large amount of energy can be concentrated into a small space. A few inches will produce the same results when placed on the electric circuit as many feet of fine platinum wire.

Improved Electric Cigar Lighters

It is capable of withstanding the enormous temperature of 1700 degrees Centigrade without change in its physical, chemical, or electrical characteristics. All danger of short circuiting due to its becoming plastic or losing its shape is eliminated.

When connected to the proper voltage this material will maintain its temperature and hold its character practically indefinitely. On account of the small amount of material it comes up to temperature very quickly. This material burns in the open air and requires no insulation of any kind.

Cigar ashes or any other foreign substance may come into contact with it without having any effect upon it whatever. Also it is not affected by moisture or by draughts of cold air.

Among the interesting experiments connected with it was one of burning it for a long period under water, where it performed exactly as when burned in the air, and showed no deterioration due to submerging.

In addition to showing great strength and its capacity to withstand such an extreme high temperature it possesses the good quality of being extremely cheap.

A 50-cent heater is guaranteed to last six months in any cigar store.

Both types are made for either A. C. or D. C. circuits and for two voltage classifications—100 to 110, and 110 to 120.

Manufactured by the Pittsburg Electric Specialties Company, No. 927 French St., Pittsburg, Pa.

NEWS NOTES

FINANCIAL.

EUGENE, ORE.—An ordinance was passed providing for the form and sale of the proposed $25,000 street lighting bonds.

LYNDEN, WASH.—The issue of $2000 additional water bonds was carried at the special election by a vote of 66 to 28. Funds are to be used for a water supply system.

MONMOUTH, ORE.—The City Council has accepted the bid of Sutherlin & Co. of Kansas City, for the issue of $25,000 bonds to be issued for the installation of the new water system. Work will be commenced as soon as contracts are let.

RIDDLE, ORE.—At a special taxpayers' election Riddle voted bonds of $15,000 for the construction of a waterworks system, the old plant being entirely inadequate; also $13,000 for construction of a complete sewer system. Both issues were carried and work will begin as soon as the contracts are let.

OAKLAND, CAL.—A $5,000,000 mortgage, given by the Union Water Company to the Anglo-California Trust Company has been recorded in the county recorder's office. The mortgage covers realty holdings of the water concern in this and other counties. The Union is a subsidiary concern of the $200,000,000 United Properties Company of California, at the head of which are F. M. Smith and W. S. Tevis. The mortgage is given in security of the company's issue of bonds.

TRACY, CAL.—A number of applications to purchase the bonds for the water and sewer system have been received. The N. W. Halsey Co. of San Francisco made an offer to buy $21,000 worth of the long time bonds and as many more of the short time bonds as they could get at par, plus attorney's and other incidental fees. The West Side Bank of Tracy offered to purchase $19,000 worth of long time bonds and as many more short time bonds as they could buy, and the Bank of Tracy presented an offer for $10,000 worth of the long time bonds, with the privilege to buy a number of the short term bonds. All offers were for par, plus incidental expenses. On motion it was decided to accept the different bids and to a'thorize the sale of the bonds.

RIVERSIDE, CAL.—A trust deed, involving $5,000,000 has been filed in the office of County Recorder Logan, consisting of one of the biggest documents of the kind ever filed in Riverside County. The deed conveys to the International Trust Company the property of the Southern Sierras Power Company, securing an issue of $5,000,000 first mortgage, 6 per cent, 25-year gold bonds. The Southern Sierras Power Company is the corporation which is building a transmission line from San Bernardino to Bishop, to connect with the plants of the Nevada Power Company, and which will have a big steam plant at San Bernardino. The company was represented by F. A. Worthley of this city in securing franchises. Other franchises owned by the company cover the streets and highways of both Riverside and San Bernardino counties, and of Perris and Corona in this county. These, and other franchises, together with all the other franchises, together with all the other property of the company, such as transmission lines, buildings and improvements and the entire capital stock of the Corona Gas and Electric Light Company, comprise the security for the bonds.

SAN FRANCISCO.—The stockholders of the Pacific Gas & Electric Company, at meetings held at the company's offices at San Francisco, on October 23, authorized the creation of a new mortgage upon the company's properties under which it may, from time to time, as required, issue its bonds to the maximum amount of $150,000,000. This new bond issue will provide the means for refunding or retiring at maturity, or as occasion may arise, all of the existing bond issues of the Pacific Gas & Electric Company and of subsidiary and controlled corporations. This will eventually absorb about $67,000,000 of the new issue. The remainder of the new issue, about $83,000,000, will be available for such extensions, additions, improvements, betterments, etc., as the growth of the company's business may require. During the past five years the company has expended more than $17,000,000 in enlarging and improving its service, and, assuming about the same average rate of growth in the future, the new bond issue will supply the company's needs for new capital for approximately twenty-five years. It is not the company's intention to issue any of these new bonds immediately. It is simply providing the financial facilities for meeting increased demands for its service that will inevitably arise out of the growth of the population and the multiplication of industries in Central California during the next decade, and the bonds will be issued and sold only as required from year to year to pay for this new construction. At this meeting the stockholders also approved an increase in the common stock of the company to $150,000,000, this being also the amount of the new mortgage which was authorized. The company does not contemplate the immediate issuance of any of this stock, the action of the stockholders in authorizing the increase having simply been taken to enable the company to comply with the California statute under which no California corporation may have outstanding indebtedness in excess of its subscribed capital stock.

ILLUMINATION.

ELLENSBURG, WASH.—Resolutions have been passed creating special improvement districts for the installation of street lights.

SANTA BARBARA, CAL.—The Santa Barbara Gas & Electric Company bid in the franchise for gas mains along certain county roads in Montecito, paying $100 for a 50-year franchise.

EL CENTRO, CAL.—The Imperial Valley Gas Company is perfecting plans for the extension of its gas service throughout the south and southeast portions of El Centro. This company may also put a gas service into Brawley soon.

LOS ANGELES, CAL.—W. A. McNall & Co., of Pasadena, have placed an order with the Los Angeles Brass Mfg. Co., 711 North Main Street, which calls for 171 ornamental bronze lighting posts, to be used to beautify South Orange Grove Avenue, Pasadena.

GLENDALE, CAL.—The Glendale Light & Power Company has offered to furnish the city of Tropico with 32-candle power street lights at $1 each per month. In addition to this the city must pay the cost of installing the system and furnishing all lamp renewals.

SAN BERNARDINO, CAL.—Manager C. M. Grow of the Southern California Gas Company has announced that a sufficient number of Rialto residents have signed up for use of gas and that the construction of the line will start as soon as material is secured. This will be a high pressure system, similar to the one reaching out to Highland.

SAN RAFAEL, CAL.—The Pacific Gas & Electric Light Company has a number of men in Southern Marin securing contracts for the furnishing of gas. At present men are working in Sausalito, Corte Madera and Larkspur, with a view of signing up householders. If the required number are obtainable the company will begin at once to extend its mains to this territory. At the present time a Mill Valley company is engaged installing a gas plant in that district.

TELEPHONE AND TELEGRAPH.

ODESSA, WASH.—Representative Crandall of the Pacific Telephone & Telegraph Company has addressed the council relative to the obtaining of a telephone franchise for the company in the town of Odessa.

REEDLEY, CAL.—At a meeting of citizens held here in the office of D. L. McKeel, initial steps were taken looking to the formation of a co-operative telephone company in Reedley. A committee consisting of Lucas Keyser, T. M. Lane and Carson Reed has been appointed to take up the question.

FLORENCE, ORE.—Applications for franchises have been made by the Florence Electric Company, for light and power, and by the Florence-Mapleton Independent Telephone Company, for a telephone system. An election was held October 16 for voting these ordinances.

SANTA FE, N. M.—The Ranchers' Telephone Company has been incorporated with capital stock of $3000. The main office will be at Wagon Mound and R. K. Odell will be statutory agent. The incorporators are: R. K. Odell, S. M. Reiland and S. Foutz of Wagon Mound, J. P. Van House and A. Urbahns. The company will erect a telephone line near Wagon Mound for the convenience of ranchers.

SAN FRANCISCO, CAL.—The attempt of the City and County of San Francisco to collect $502 license tax from the Pacific Telephone & Telegraph Company failed when Superior Judge Seawell sustained the corporation's demurrer. Judge Seawell upheld the validity of the constitutional amendment relating to the separation of State and municipal taxes for public service corporations, thus making it necessary for the city to either file a new complaint or drop its suit.

INCORPORATION.

MODESTO, CAL.—The Modesto and Empire Traction Company has been incorporated for $20,000; by T. K. Beard W. H. Frazine, W. F. Beard, J. M. Walthall and L. L. Dennett.

TRANSMISSION.

LIVERMORE, CAL.—The Livermore Water & Power Company is preparing to extend its electric lines to Sunol from Pleasanton, a distance of five miles.

SAN BERNARDINO, CAL.—The contract for the erection of the building for the central plant of the Southern Sierras Power Company here has been awarded to Chas. C. Moore Company of San Francisco.

RIVERSIDE, CAL.—The Southern Sierras Power Company has let a contract in Los Angeles for the construction of between fifty and sixty miles of distributing lines in Riverside and San Bernardino counties.

PROSSER, WASH.—The Pacific Power & Light Company has applied to the Board of County Commissioners of Benton County for a franchise for a term of 50 years for the construction of transmission lines within that county.

TWIN FALLS, IDAHO.—Mr. Bacon of the Beaver River Light & Power Company has made application for a franchise for furnishing light and power to the city. The matter will be taken up by the City Council as soon as Mr. Bacon can appear.

VISALIA, CAL.—Application has been made to the Board of Supervisors of the county of Tulare for a certain franchise granting the right to construct and for a period of 50 years to operate and maintain an electric power system upon certain highways in said county.

THE DALLES, ORE.—Engineers representing the Pacific Power & Light Company, Portland, are preparing to make surveys for a high power transmission line between Wallula and The Dalles. The proposed line will be 130 miles long, carry 66,000 volts and cost about $400,000.

CLOVERDALE, B. C.—The British Columbia Electric Company will soon commence the construction of a power line from this place to Blaine, Wash.

WHITE SALMON, WASH.—Preliminary work has been started on the power dam which is to be built at the Narrows near here by the Northwestern Electric Company.

SAN SIMON, ARIZ.—The Virtue Mining Company plans for the erection of an electric power plant in Cave Creek Canyon, with a distributing system to serve the many pumping plants in this district.

HAZELTON, B. C.—The Rocher de Bocale mine plans for the erection of a hydroelectric power plant for mine operation. John F. Cowan Salt Lake City, Utah, is interested in the development of this property.

GOLDENDALE, WASH.—The Pacific Power & Light Company has been granted a franchise for a transmission line from Goldendale to Centerville, a distance of about seven miles. The estimated cost is $7000.

KLAMATH FALLS, ORE.—It is the intention of the Siskiyou Light & Power Company, whose head office is at Yreka, Cal., to have all of its subsidiary plants connected by power lines with the main plant at Fall Creek, which is on the Klamath River below Keno, about forty miles from this city.

HANFORD, WASH.—The American Power & Light Company has acquired the Hanford Irrigation & Power Company and will operate in connection with its other properties. The local plant on Priest Rapids will be enlarged and the capacity increased. G. W. Talbot is president, and A. S. Grenier vice-president of this company.

PORTLAND, ORE.—The Mount Hood Railway & Power Company has assigned to the City of Portland the right to appropriate such of the waters of Bull Run as may be necessary for a domestic water supply but reserves the right to use all excess. This amiable adjustment should materially hasten the company's power development on Bull Run.

BELLINGHAM, WASH.—Arrangements have been completed with the Western Canada Power Company to supply the motive power for the Bellingham-Skagit interurban railway, now under construction between Bellingham and Mount Vernon by the Stone & Webster Corporation. The traction system will be in operation by the summer of 1912.

BOISE, IDAHO.—The Kuhn interests of Pittsburg have purchased the Swan Falls power plant on the Snake River, near this city, and the Boise interurban railroad, operating between this city and Caldwell. The consideration is reported to be $2,000,000. The Kuhns contemplate trolley line extensions from Boise to Ogden, Utah, traversing irrigation district.

REDDING, CAL.—Work upon the greatest electrical power plant ever attempted in California is said to have been begun in the big bend of Pitt River by the Northern California Power Company of this city. One hundred and twenty-thousand horsepower will be developed from 250,000 inches of water turned from Pitt River near the town of Wengler. It is estimated that the total cost will be $4,000,000. It will be by far the largest electrical power plant in the State. The ditches and tunnels will have a combined length of five and one-quarter miles.

STOCKTON, CAL.—The San Francisco & Sierra Power Company officials announced Tuesday, after the Supervisors had granted a franchise over the county roads from Manteca to Stockton, that inside of 60 days electricity would be furnished consumers here. For the past two weeks the company has had agents making the rounds of the business section securing contracts, and they will continue to work. It was stated that fully $300,000 will be expended in placing one of the finest underground systems in the State in the streets of Stockton.

EUREKA, CAL.—Negotiations have been practically closed here for the transfer of the Blue Lake light and power plant to the Western States Gas and Electric Company. The plant has been owned and operated a number of years past by the Minor Mill Lumber Company. With the purchase of the Blue Lake plant the electric light and power situation in Humboldt County will be under the complete control of the Western States. A year ago the Western States Company entered the Humboldt field by the purchase of the holding of the Humboldt Gas & Electric Company at a cost of over a million dollars. Subsequently it absorbed the light and power plants in Arcata, Fortuna and Ferndale and is now to take over the Blue Lake. Since the purchase of the Humboldt gas and electric system the Western States Company has spent over $250,000 in acquiring smaller plants of the county.

REDDING, CAL.—The Northern California Power Company is moving the construction equipment from its recently completed Coleman hydro-electric plant over to the big bend of the Pitt River, near Wengler, 67 miles north of Redding. A diversion dam for 250,000 inches will be installed for a new power plant with an estimated capacity of 120,000 horsepower. Water from Pitt River will be turned direct into a tunnel 6000 feet long and 24 feet wide by 26 feet high. In all there will be five tunnels. The combined length of the tunnels and canal will be 5 1-4 miles. The canal will be 32 feet wide at the bottom, 50 feet wide at the top and 15 feet deep. At the outlet a drop of 464 feet will be obtained. Only 850 feet of steel pipe line will have to be constructed at the lower end of the system, to connect with the water wheels. A unique feature of the tunnel work consists in the use of steam shovels for mucking throughout, something never attempted before in this state. A power line is being constructed 24 miles from the Kilarc station to the new site in order to supply current for operating the air compressors, etc., of the construction plant. Steel towers, spaced five to the mile, will be used instead of poles to carry three three-phase power circuits.

TRANSPORTATION.

ALBANY, ORE.—The contract for grading the electric railroad from Albany to Eugene has been let. It is predicted that electric cars will be running over this line early next year.

SEDRO-WOOLEY, WASH.—The Bellingham and Skagit County Interurban Railway Company has made application for a franchise to operate an electric lighting and power system in this city.

NATIONAL CITY, CAL.—The work of relaying the track of the electric division of the San Diego Southern Railway, between National City and San Diego, will start at once. New ties and heavier rails will be put in.

SAN DIEGO, CAL.—The City Council will receive sealed bids up to November 20th for the purchase of a franchise granting the right to construct, maintain and operate a street railway for a period ending September 1, 1952.

MEDFORD, ORE.—Messrs. Doyle & Narren, who represent a company which contemplates the construction of an electric railroad from Grants Pass to Ashland, Ore., have been in this vicinity looking over possibilities.

TUCSON, ARIZ.—Negotiations leading to the building of the proposed street railway extension from the present university terminus to a point a mile and a half east of the speedway, are being made with property owners by C. K. Durbin, representative of Sanderson & Porter Company. Property owners have pledged $40,000 worth of property to the company as an incentive. The company is now said to be asking for a larger guarantee.

NEW WESTMINSTER, B. C.—The British Columbia Electric Railway Company has made arrangements for fitting all cars now in operation with Westinghouse multiple unit controls. This installation involves alterations to the various truck bodies and cars are undergoing repairs.

STOCKTON, CAL.—The survey for the route of the Central California Traction Company's extension from its main line at Campton to Lockeford has been completed and the new feeder for the interurban road will soon be constructed.

ALBANY, ORE.—The Oregon Electric Railway is being rapidly extended from Salem to Albany so that it is likely that service will be ready between Portland and Albany by January 1st. President Carl R. Gray states that the extension to Eugene awaits only the acquisition of right of way.

SOUTH VANCOUVER, B. C.—The British Columbia Electric Railway Company has notified the residents of this place in response to communications urging extensions of car lines in this district, that action on extension work will not be undertaken this year on account of heavy construction work, but will be taken up next season.

REDLANDS, CAL.—C. S. Turrill, president of the Redlands University Railroad Company, recently organized with a capital stock of $15,000, has petitioned the Board of Trustees for a franchise to construct a line on Colton avenue from Orange street to Cook street, for fifty years, giving the privilege of carrying passengers, express and freight.

LOS ANGELES, CAL.—The Board of Supervisors has passed an ordinance granting to H. E. Huntington, a franchise to construct and for a period of 40 years to maintain an overhead crossing across El Monte road in the County of Los Angeles, and to construct, operate and maintain a double track electric street railway line thereover.

SAN FRANCISCO, CAL.—The announcement is made by the United Railroads that steps are being taken to bring the decision of the U. S. District Court of Appeals in the Geary street road case before the Supreme Court of the United States. Wm. H. Abbott says: "I am now preparing a petition for a writ of certiorari to take the decision of the Appellate Court before the U. S. Supreme Court. This will result in putting a stop to all proposed construction of the municipal road on Market street, and on Geary street west of Thirty-third avenue for at least two years."

BERKELEY, CAL.—Formal notification that the Southern Pacific was ready to convert its interurban lines in this city from steam to electricity, following the practical completion of new lines in this city and the reconverting of the old lines, was made by the company to the City Council at its meeting yesterday. The notice covered all its local lines north of Shell Mound Park, including the California street Solano avenue, and Ninth street loop, the Shattuck avenue line and the Ellsworth street line. Though no definite date was given by the company as to when it would be ready to convert the lines, it is announced unofficially that the change is to be made on the lower road on California and Solana street in November.

SAN RAFAEL, CAL.—S. M. Augustine and the Mt. Venice Co., have transferred 57 acres of their tract near McNear's Point to E. B. McNear of Petaluma. The purchase of so much land by the McNears in this locality recently has considerable significance, in view of the fact that John McNear is one of the directors of the Petaluma, Sebastopol and Santa Rosa electric road. Some weeks ago E. B. McNear increased his holdings in this locality, and it is reported that he is anxious to get more. People who appear to know, say that it is the intention of the Petaluma company to begin extending its line via McNear's Point in the early spring.

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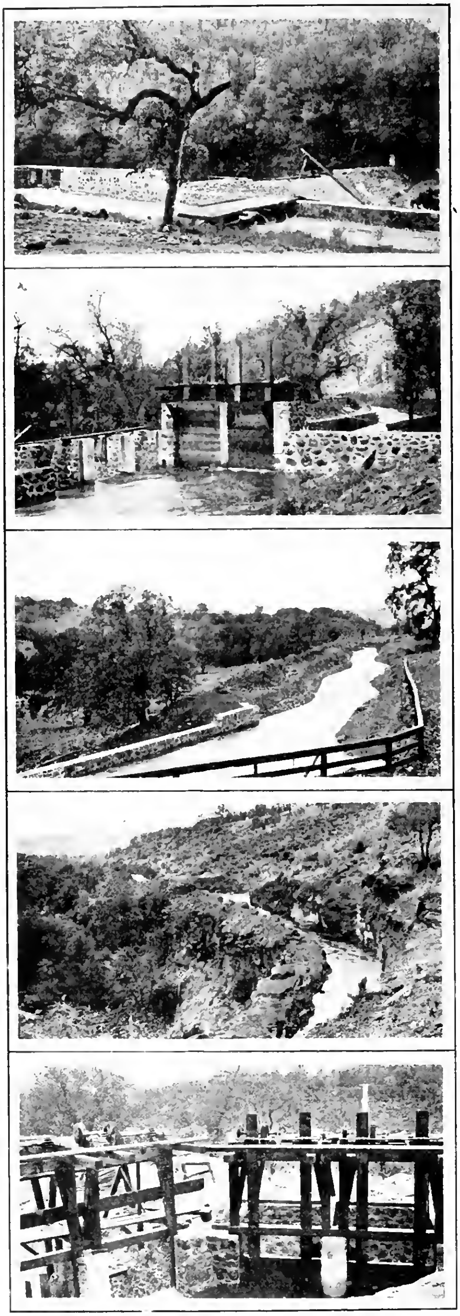
General View of Coleman Power House and Pipe Line.

THE COLEMAN PLANT

By Rudolph W. Van Norden
Member A. I. E. E., A. S. C. E.

OF the plants which have been built by the Northern California Power Company, the Coleman division is the fifth and largest. It is interesting from the manner in which many problems of construction have been treated, and represents the most advanced ideas for high efficiency in operation and maintenance, together with the utmost economy in construction compatible with good design and work. It will perhaps assist the reader in comprehending the manner in which the development has taken place by giving a short description of the system.

Two watersheds are employed, the one being Battle Creek, and the other Old Cow Creek.* On the former are situated four of the plants: Volta, South, Inskip and Coleman. On the latter watershed is situated the Kilarc plant. Water is first diverted from the north fork of Battle Creek, and this supply is augmented by many springs in the country north of this stream. This water is carried through a series of earth ditches to a point near Shingletown, where a fall of 1200 ft. serves the Volta power house, the first plant which the company built, and which has a capacity of 8500 horsepower. From this point water is conveyed in open canal, crossing the north fork of Battle Creek, where additional supply is added, following the con-



Diverting Dam and Intake, South Battle Creek.
Intake and Water Gate Below Diverting Dam.
Typical Waste Weir
Section of Canal in Rock
Headgate and Siphon No. 1. Waste Gate on Left.

tour of the country and joining with another canal which brings water from a diversion in the south fork of Battle Creek. This combined flow is utilized in the South power house which is situated on South Battle Creek with a capacity of 5400 horsepower. From this plant the flow is again diverted into a canal which follows the north bank of South Battle Creek for a distance of five miles, passing en route through a number of tunnels, to the Inskip plant, which is also situated on South Battle Creek and from which is delivered 8000 horsepower.

After passing through this plant the water is again diverted into the new Coleman canal and is carried for a distance of 10½ miles, crossing North Battle Creek and several smaller creeks, each of which adds its quota of water. This canal delivers water to the new Coleman plant, and thence discharges into main Battle Creek.

The development of this system is a consummation of plans which were made over ten years ago, but there was little idea then that the entire development could be carried out or that there would be a market for this power within so few years. The construction progress has, however, been the result of a constantly growing demand for power which has been apparent almost as soon as each of the various plants have been finished. In the new plant the attempt has been made to design an installation entirely modern in electrical and mechanical equipment and so arranged as to afford the highest operating efficiency, both from the point of operating costs, low depreciation and high grade service at absolutely the minimum cost of installation. All materials entering into the construction have been of the highest grade and every device has been employed, without extravagance, for safety. The construction has been performed entirely by the company's force and the closest attention has been given to every detail of the work by those in authority.

Canal.

The canal is similar in design and construction to other canals on this system, and in fact, follows closely old California mountain practice. Water is diverted about one-eighth mile below the Inskip power house by a dam across South Battle Creek. This dam is of rubble masonry construction, 15 ft. high, having a gravity section with an Ogee face. While the entire length of the dam has this section and can be used as a wier, there is a space 50 ft. long in the center which is slightly lower than the rest of the crest, which under ordinary circumstances would carry the overflow. At the north end of the dam is a rubble stone wall perpendicular to its axis and forming the outer wall of the canal. It extends above the dam for 50 ft. and then is turned into the bank, two large intake openings admitting the flow into the canal.

This wall extends below the dam about 300 ft. and terminates in two main gates which control the flow into the canal. The design of these gates follows the practice used throughout the system, being constructed of heavy timber, bolted to the rear of which are iron strips, bearing against rollers. This arrange-

ment makes the movement of the gates comparatively an easy matter. They are raised and lowered by means of a steel rack and pinion gear. Between the two gates, and on either side are abutments between which the gate frames are mounted. Immediately joining the gates, and in the canal wall are a pair of waste gates, which may be opened to return the flow to the river should it be necessary to make repairs on the canal.

The canal now winds its way along the side hill about two miles to the first inverted siphon. The country traversed is rolling and more or less rocky, the ground being largely boulders, cemented by igneous action, having a hardness almost equal to solid rock formation. There are many places on the canal line where solid rock was encountered and in some of these the work was not only very difficult but the greatest care was exercised in order that the outside wall of the canal would not be shattered. In this section is the only tunnel. It has a length of 367 ft., a width of 12 ft., and a height of 9 ft., and it is unlined.

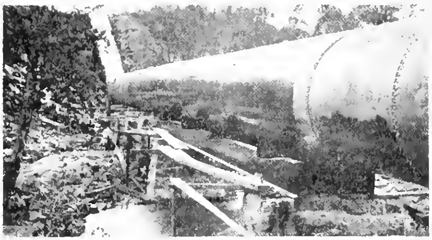
The first siphon crosses the north fork of Battle Creek. It is riveted steel pipe ¼ in. thick and having a length of 1270 ft. The inside diameter is 76 in. and the greatest head on the pipe is 80 ft. At the creek crossing the pipe is carried on rubble masonry piers, the central 50 ft. span, being supported on a Howe truss bridge. The entrance of this siphon likewise has its equipment of a pair of sluice gates and a pair of waste gates. This siphon terminates in a large block of concrete which acts as a header for a continuation of the canal.

The canal now continues for a distance of 1000 ft. and entrance is made to the second siphon. This siphon is one of the particularly interesting engineering features of this work. It has a total length of 3557 ft. The greatest head is 115 ft. The greatest head on the concrete section is 46 ft. For the first 1815 ft. it is of reinforced concrete with an inside diameter of 87 in. The thickness of concrete at the bottom is 7 in. and 5 in. at the top. Concrete pipe, while perhaps costing more than steel pipe, will have a much greater life.

The pipe is made in wooden forms, both inside and out. It is reinforced with one layer of triangle mesh fabric, the weight of the fabric being varied in proportion to the head on the siphon, to get a safety factor of two without reference to the strength of concrete. For stiffening a longitudinal strip is placed along the top and also the bottom of the pipe. Between the concrete and steel sections is an expansion joint inclosed in a block of concrete 10 ft. square, and having a depth of 12 ft. A complete crushing and mixing plant was erected convenient to the pipe.

The steel section has a minimum inside diameter of 86 in. and a thickness of ¼ in. At the lowest point, where it crosses Baldwin Creek, this siphon, like the first one, is supported on rubble masonry piers, and the longest span is carried on 15 in. I beams. This crossing is not as difficult or extensive as that of the first. From the outlet of siphon No. 2 there is no interruption in the canal until the forebay is reached.




Commencing a Section of Concrete Pipe
Building Concrete Pipe
Crushing Plant and Finished Pipe in Place
Steel Section Crossing Baldwin Creek
Entire Siphon, Concrete Section in Distance.

Between the intake and the first siphon the canal has a capacity of 325 second feet or 13,000 hydraulic miners' inches of water. The width at the bottom is 11 ft. and the depth of water 5½ ft.

As the canal is not lined throughout, there is no attempt to maintain any predetermined slant to the sides. In fact, the material at almost all points is such that the sides are practically vertical. At a few places where there might be danger of the side wall falling in, a dry rubble wall has been built to form a sort of rip-rap. Below the outlet of the second siphon the canal has a greater capacity than at the entrance, as considerable water is supplied from the several creeks which are crossed by the siphon. In this section the canal has a width of 16 ft. on the bottom; the depth of water is 6½ ft. and the normal capacity is 500 second ft. or 20,000 hydraulic miners' inches of water.

The water supply from the small streams is added as follows: A small masonry dam in North Battle Creek diverts the flow into a canal, which carries the water two miles, and delivers it into Darrah Creek. This water with that of Darrah Creek flows down the creek to a point below the junction with Baldwin Creek, when another small diverting dam is reached. From here the flow is carried in a semi-circular steel flume having a diameter of 10 ft. to a point near the outlet of siphon No. 2, where it is delivered into the main canal.

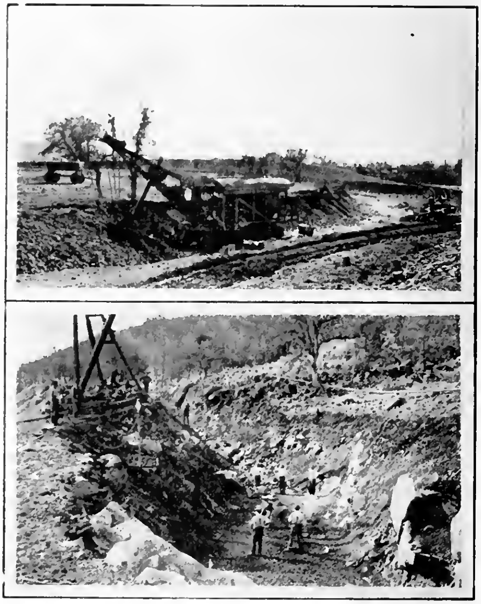
The 9 spillways throughout the length of the canal are constructed of rubble masonry. Six of them are at points where the canal crosses small canyons or gulches. In construction, a masonry wall is built across the gulch acting as the outer wall of the canal. At the bottom of this wall is a concrete sand box and in the wall itself are a pair of sluice gates consisting of cast iron plates on brass bearing guides. The openings are 30 x 30 in. and are operated by a screw and nut in a bronze bearing. The dimensions of the spillways are: length 140 ft.; crest above bottom of ditch 8 ft.

The canal was excavated throughout by means of steam shovels, four shovels being used at times. Two were No 49 Marion ¾ yard rock dipper, 25 ft. boom and 14 ft. dipper sticks, one was a model 30 Vulcan, and one a No. 60C Bucyrus. The latter is of a considerably greater capacity than the other three and it is interesting to note in this connection, that due in all probability to its larger capacity and longer boom, its work was not as satisfactory either in economy or speed of excavation, as the smaller machines. Under the best conditions of work, it was observed that one Marion shovel working on a day and night shift could excavate 615 yards per day.

In excavating the canal the first operation was to drill three, but more generally, four holes abreast and to the bottom of the cut. These holes were drilled with 2¼ in. Burleigh drills, and the rows were spaced about 8 ft. apart. The amount of explosive in loading was determined from the nature of the drilling. The explosive used was 40% giant, 20% stumping powder and black powder. The holes on the lower side of the canal were invariably loaded lighter than those on the upper side, to prevent shattering the outer wall. From 20 to 26 holes were fired from a battery to a round.

After the shovels it was necessary to clean and trim the cut. This was done with the derricks, mounted on the lower bank. There were eight of these derricks, two being driven by electric motors, and six with air driven hoists. With each derrick was a complement of about 14 men, whose principal work was to load skips by hand. These skips are hoisted out of the cut and dumped over the outer bank.

The steam shovels, as well as the hoists already mentioned, were operated by compressed air. This was supplied wherever necessary from 4 in. mains, laid on the ground along the line of canal. Air was delivered directly into the boilers on the shovels.



Forebay Reservoir Excavation, Penstock Intake in Middle Distance.

Cleaning and Trimming Canal Excavation Following Steam Shovel.

This was found to be more economical than using fuel hauled over mountain roads from 15 to 25 miles. On the other hand, electric power to drive the compressors, being surplus power, cost practically nothing. There were four compressor plants, one near Siphon No. 2, one about one-half way down the canal, one about three-quarters of the distance, and the last one at the boiler shop between the forebay and power house. These compressor plants were naturally temporary affairs, although the foundations for the machines in all cases were well constructed of concrete. The largest of these plants, which was the second named, was equipped with six compressors as follows:

1 Ingersoll-Sargent two stage compressor, capacity 550 c.f.m. driven by a 150 h.p., 2000 volt G. E. motor.

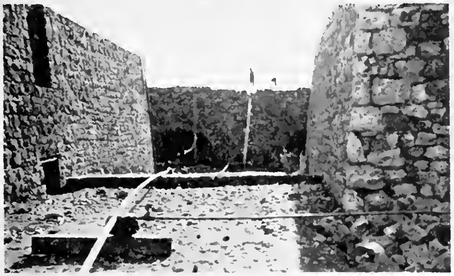
1. Ingersoll-Sargent 420 c.f.m. compressor, and 1 Laidlaw-Dunn-Gordon 240 c.f.m. compressor, both being driven from a common shaft by a 150 h.p., 440 volt G. E. motor.

2 single stage Giant compressors, capacity 220 c.f.m., driven by 50 h.p. Bullock motors.

1 two stage Laidlaw-Dunn compressor, capacity 880 c.f.m., driven by a 200 h.p., 2000 volt Form M, G. E. motor.

The other compressor camps were more or less similar in equipment to this camp, but in no case of as great a capacity. In some cases it was necessary to pump water a distance of several miles from Battle Creek to supply the camps and compressors. A transmission line was built early in the work from Inskip power house to Coleman. This line was tapped wherever necessary to deliver 6600 volt, 3-phase current. Eventually this line will be used for 66,000 volt transmission.

The canal terminates at the forebay which consists mainly of two wing walls thrown up by excavation with a steam shovel. These walls flare out from



Penstock Intake.
Six-foot Pressure Pipes.

the penstock which is of rubble masonry. The penstock has a straight section 17 ft. wide in which are placed the main submerged sluice gates, each having an opening 6 ft. high and 8 ft. wide. The water, however, has a depth of 18 ft. Beyond these gates the penstock walls diverge until the width between them is 50 ft. Entering the front wall are the two main pipe lines. The ends of these pipes are flared where they pass through the wall, and are given an elliptical section.

There will be no screens in this penstock, but in the canal before it empties into the forebay will be placed a set of grizzlies, and a waste gate and sand box. The grizzlies are built up of 2¼ in. x ½ in. steel bars, spaced 2 in. apart. They are mounted in a frame of railroad iron, and set in inclined position in masonry walls.

Pipe Lines.

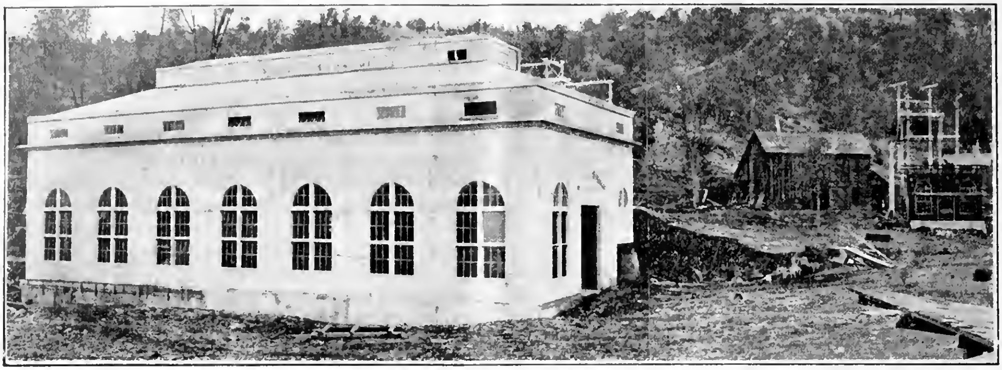
There are two pipe lines laid parallel to each other, although there are slight variations due to the contour of the hill down which the pipes are laid. These pipes are built of steel plates, double riveted on the long seams and single riveted on the round seams in the upper sections, but in the lower sections the round seams are double butt joints, and the long seams triple riveted. The pipes have a diameter at the tip of 6 ft. and a thickness of ¼ of an inch. This tapers to a diameter of 5 ft. and at the bottom a thickness of ½ in. Just before the approach to the power house both pipes, in order to maintain an even grade, pass through tunnels, one being about 100 ft. and the other 400 ft. long. This plant being equipped with three main generating units it is necessary in adopting two pipe lines to make a third connection common to each. This was done by placing a saddle on each pipe, the connections from which converge to a steel Y. In each of the pipes beyond the saddle is a 48 in. hydraulically operated gate valve. In each of the converging pipes for the three units and just before they reach the Y there is placed a 48 in. gate valve similar to the others. Beyond the gate valves of the two main pipes and also the Y of the third pipe direct connection is made horizontally under the level of the power house floor to the water wheels. A pipe connection to supply the exciters is taken from each of the converging pipes already mentioned through saddles placed on these pipes. Each of these connections is a pipe 12 in. in diameter and each after passing through outside steel screw stem operated gate valves join in a T connection from which is taken a common pipe 12 in. in diameter. This also passes under the power house floor and is carried through a Y branch to the exciter water wheels. The station water supply system supplying water for various purposes in the building and about the grounds is taken from this exciter pipe and the desired pressure is obtained by passing the water through a pressure regulator.

The main gates are operated by the main water pressure on the operating pistons, and is controlled by means of four way valves. These gates were designed by Allis-Chalmers Co. and built by Crane & Co.

The total length of the main pipe lines is 3600 ft. The total fall from the surface of the reservoir when full to the surface of the tail water at the power house is 487.53 ft.

Power House.

The power house is situated at the edge of the incline about 300 ft. back from Battle Creek. This was done to shorten the pipe lines as much as possible and also to provide for a receiving pond at the lowest possible level, to give draft for the water wheels. The power house is a steel frame structure, mounted on a solid block of concrete, as a foundation both to the building and the machinery. The foundations are carried down to a stratum of sandstone, which is slightly below the level of the bottom of the draft tubes. A tunnel 12 ft. wide and 9 ft. deep runs throughout the length of the building directly in the rear of the machine foundations. This tunnel, described later, is used for the various systems of pipings



Power House, Pipe Line and Arrester House During Construction.

and for oil tanks, etc. The length of the building is 118 ft. and the width 59 ft. It is arranged in two bays. In the main bay having a width of 35 ft. is placed all of the generating machinery. In the other bay is placed the low and high tension switching apparatus. The walls are of reinforced concrete construction in the form of Hyrib expanded steel covered with cement plaster, and have a thickness of 2 in. This construction makes the building absolutely fireproof and except for the window frames and sashes this feature is carried throughout. The danger of fire from the small amount of wood contained in these parts is remote, as any probability of fire would be from sources within the building and probably never from fire which could be communicated from the outside.

In the main bay are placed the three main generating units, and the two exciter units. In a recess under the switchboard and in the center of the building are all the auxiliaries. The arrangement of apparatus has been carefully considered from the standpoint of operation, this system having, like all large transmission systems, its own problems and peculiarities to contend with. It is intended that a man at the switchboard will at all times have complete control of every part. At the same time he will be within sight of every piece of apparatus and also within sight of the assistant operator who may be at any part of the building. This reduces the efficient running force to two men, and in case of emergency the plant can be operated entirely by the man at the switchboard.

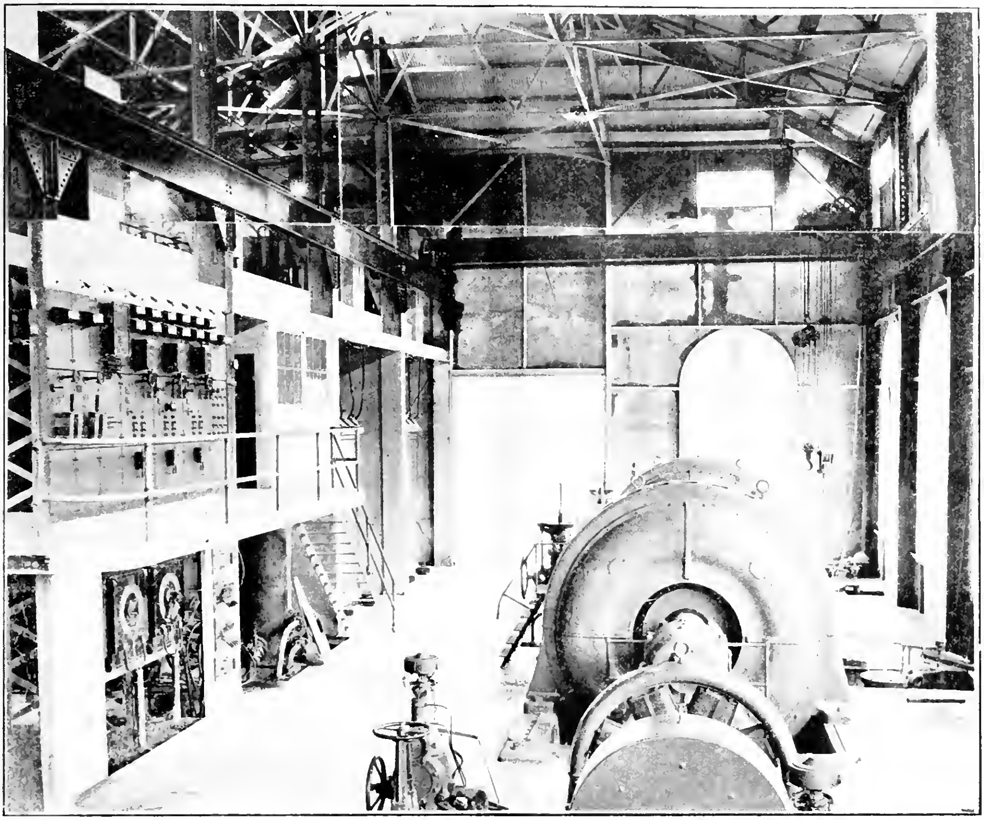
At the rear of the main bay is a line of supporting columns which carry the second and third floors in the building. Between these columns and setting back from the main bay are the cells containing the four raising transformers. On the second floor, which extends between the four center columns of the building, is the switchboard and controlling apparatus, 10 ft. above the main station floor. A platform extends out into the main bay 4 ft. which enables the switchboard operator to see every part of the interior. At the left of the switchboard are two rooms, one of which is used as an office or record room, and the other as a telephone booth. At the right of the switchboard is a dressing room and lavatory for the operators. To the rear of the switchboard is a storeroom.

On a level with this floor and in the rear, extending the entire length of the building, is the high tension operating room. This is reached from the switchboard through two fire-proofed doors. In this room, mounted on the floor are seven sets of 3-pole 66,000 volt oil circuit breakers. Directly over these circuit breakers and supported from the steel frame of the building are the disconnecting switches which operate in connection with the circuit breakers. On the rear wall of the building are mounted the line disconnecting switches, the choke coils and line ammeters, and directly above these, placed in the wall are the wall insulators through which the outgoing lines pass.

The third floor of the building is 10 ft. above the switchboard floor and occupies in width only the space above the transformers, but extending throughout the length of the building. On this floor are placed generator and transformer, 6000 volt circuit breakers and their disconnecting switches, all being mounted in concrete compartments. The connections from the generators to these switches pass under the main station floor and thence up the walls between transformer compartments and directly into the circuit breaker compartments. These conduits consist of three in. Orangeburg fibre laid directly in the concrete. The cables connecting the generators and the switches are 600,000 c.m. varnished cambric covered and weatherproofed.

The interior of the building is given a plain plaster finish without any effort to conceal the structural steel of the frame. The roof is of galvanized corrugated iron directly mounted on steel channels. The gutters are formed into the coping and are of reinforced concrete. There is a monitor 5 ft. higher than the main roof and 12 ft. wide which was adopted to give ventilation during the summer months, when there is always experienced much warm weather. This monitor is amply supplied with windows which can be left open at least part of the year. The underside of the roof and all structural steel are painted a pale blue, giving a light and pleasing finish.

The exterior finish of the building is plain, only enough decorative finish being allowed to give the building a chaste appearance and some attempt at architectural symmetry. The upper circular part of

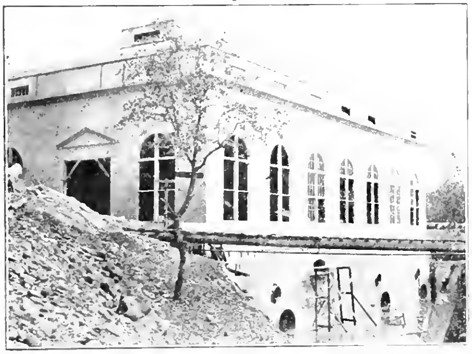


Coleman Power House, Interior

the windows are finished with an ornamental projection which prevents rain and water running down the wall from leaking past the window frames. Between the main part of the wall and the second row of windows there is a lintel or cornice which, while it is proportioned for a decorative effect, acts as a water shed in addition to the projections over the windows. The eaves are built into the coping and water from the roof is carried away through short pipes which are inserted through the coping.

Between the power house and Battle Creek there is a natural swale which extends parallel to and down the creek for a distance of about a quarter of a mile. This was probably caused by the throwing up of a gravel bar which now confines the creek. The existence of this swale made it possible to form a discharge canal which allows the discharge flow to join the creek at a point where a considerable drop is obtained. Beginning directly in front of the power house an excavation has been made down to the bottom of the level of the draft tubes. This excavation is about 40 ft. wide; it is lined with concrete retaining walls and floor.

By this means a pond or afterbay is formed in front of the building which maintains draft at all times. Beyond the afterbay the discharge is contracted to form a narrow straight section. This is for use of an Anderson measuring device. Beyond



Concrete Afterbay, Showing Draft-tube Openings of Main Wheels and Automatic Relief Valve Outlets

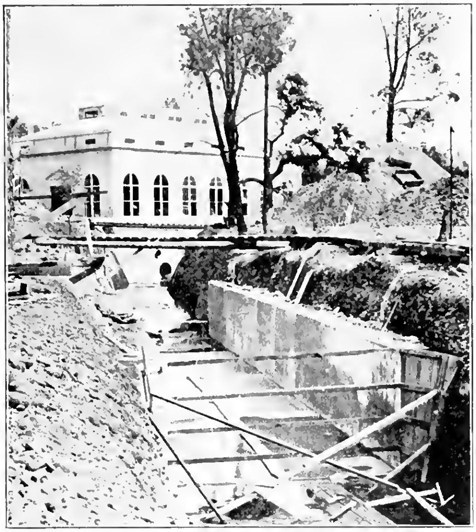
this the ditch is extended to carry the flow to a point where it can join Battle Creek.

Underneath the rear portion of the power house and on a level with the main station floor is a space 12 ft. wide and the length of the building which is utilized as a shop and storeroom. This is a handy arrangement as it brings the shop close to the center of operation. At the same time it is out of view from the main interior and is separated by fireproof walls.

Equipment.

There are three main generator units. These are placed in the main bay, the center line being parallel to the length of the building. Each consists of a 4000 k.v.a., 3-phase, 6600 volt generator, which operates at 450 r.p.m. These generators are interesting on account of their liberal design and also for the high speed at which they operate. The rotors have a diameter of 7 ft. The field poles are dove-tailed into a cast steel spider. The coils are built in the ordinary manner of strip copper one turn per layer wound on edge. Between the poles are placed the customary brass damping plates.

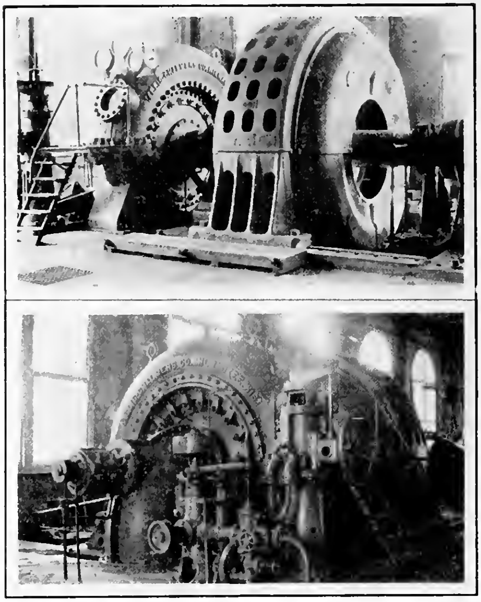
The stator or armature is built in the ordinary manner, the 3-phase windings being arranged 2 slots per pole, and are star connected. The system of ventilation and cooling is ingenious. The ventilating ducts in the laminations are placed close together at the center of the stator and the spaces are gradually increased toward the edges. This allows a greater quantity of air at the point of greatest heat. The outside cast iron frame is amply provided with ventilating openings. On both sides of the frame are bolted large cast iron end-bells. On both sides of the rotor are mounted centrifugal fan blades, held together by a shield, the whole being constructed of sheet steel and riveted. The rotary action of this part sucks air through the ventilating opening of the outside frame, thence through the openings in the laminations, past the coils, thence out on either side through the fan blades and the draft is eventually delivered parallel to the shaft in both directions.



Discharge Canal Fitted With Concrete Anderson Measuring Flume.

The water wheels each consist of a single runner of Francis type. They are inclosed in the ordinary cast iron scroll casing. The wheel is mounted close to the generator so that there are but two main bearings. The shaft is, however, continued through the runner into a third collar or thrust bearing. This consists of a number of rings integral with the shaft which run in an oil bath and take up the discharge thrust on the runner. The runner has a diameter of 34 in. and discharges in one direction into the draft tube. The wheel has a full load rating of 7000 horsepower. The makers guarantee the following efficiencies: at one-half load 78 per cent; at three-quarters load 80 per cent; at full load 82 per cent.

The penstock delivering water to the scroll lies below the power house floor. Separately mounted on two cast iron bases, at a level with the floor are the operating and controlling mechanisms of the governor.



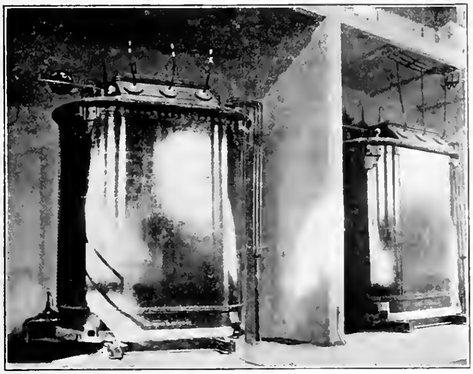
4000 K.V.A. Generator and Water-wheel 7000 H.P. Francis Turbine and Governor.

This is designed and built by the manufacturers of the water wheel but is of the Escher-Wyss type and is operated by oil under a pressure of 250 lb. per sq. in. The exciters are two in number and are placed together between the second and third generating unit at a point handy to the switchboard should it be necessary for the switchboard operator to reach them quickly. The exciter generators have a capacity of 225 kw. They are direct current, 120 volts and operated at a speed of 550 r.p.m.

The generator is of the standard two-bearing type and the water wheel runner is mounted on the end of the generator shaft and is overhung. The water wheel is of the tangential impulse type and is inclosed in a cast iron housing. The nozzle is of the needle type and is operated by a governor somewhat similar, but smaller, to those of the main machines. Within the recess, directly beneath the switchboard gallery, the office and the dressing room, are placed the auxiliaries as before stated. This space is 48 ft. long by 12 ft. wide and is on the main floor level. Within the space

are placed two motor driven oil pumps to operate the governors. These each consist of a direct current 50 h.p., 120 volt motor, driving through a Morse silent chain, a gear type oil pump which is inclosed in a cast iron reservoir. There is also placed is this space a two cylinder, 6 in. x 6 in. water cooled air compressor, belt driven by a 15 h.p., 220 volt induction motor, and also a General Electric, type FP. 7 in., transformer-oil filter.

Mounted directly under the switchboard and on an iron frame are the three main generator field rheostats. The pumping units were furnished by the Allis-Chalmers Co. of Milwaukee; the oil filter being furnished by the General Electric Co., and the rheostats by the Cutler-Hammer Co. The electrical connections between the main generators and the switches on the third floor gallery are through Orangeburg fibre duct laid directly into the concrete floor and



Two 4000 K.V.A. 3-Phase Transformers.

walls. Within each duct is placed the 600,000 c.m. muslin insulated cables. The main leads from the exciters are placed in Orangeburg fibre duct and consist of bare copper bars. This device was used to provide the large carrying capacity necessary and the Orangeburg forms sufficient insulation for the low voltage employed.

The transformers are four in number, one being a spare. Each transformer is placed in a recess 16 ft. long and 12 ft. deep. They are mounted on low structural steel cars. These cars are made up of I beams and cast iron wheels inclosed, and were designed to develop the necessary strength and at the same time raise the transformers a minimum distance of 8 in. above the floor. They run on 30 lb. T rails inserted in the concrete floor which extend out into the main bay, so that the transformers may be moved out where they can be picked up by the traveling crane.

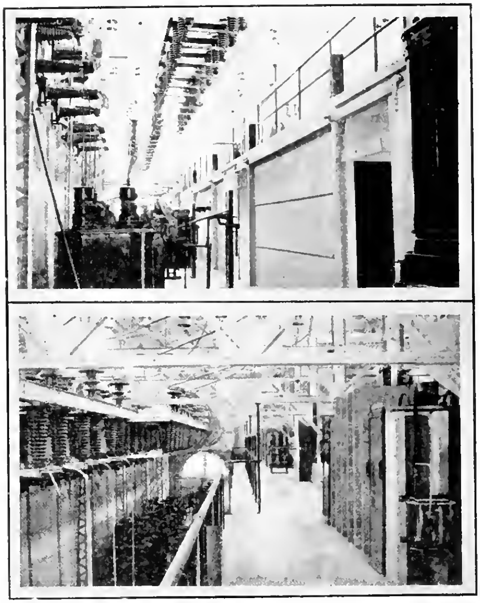
The transformers have a capacity of 4000 k.v.a. They are 3-phase delta connected on the primary side for 6600 volts and star connected on the secondary side for 66,000 volts. They rest in sheet steel cases with cast iron bases, tops and covers. The cooling is accomplished by three sets of copper coils and the transformer is immersed in oil in the usual manner. Both low and high tension leads are taken out through the cover through the conventional bushings, the high tension bushing being filled with insulating compound. The total weight of the core and case is 20 tons and of the oil, 10 tons, making the weight on the base 30 tons. Each transformer is equipped with a 4 in. quick opening valve near the bottom. This connects with the extensive oil-storage and filter system, and also with a special sewer for use in case it is desired to entirely get rid of the oil. There is also a 3/4 in. filling pipe. This is carried up the side of the case to the top and after entering extends to the bottom of the case. Through this pipe oil may be delivered from the storage tanks and incidentally through the filter, directly to the bottom of the transformer. Thus the transformer may be filled without splashing or getting air trapped under the oil.

The switchboard is of the conventional panel type, the slabs being of black slate. There are 7 panels. The first two are each for an exciter. The third is a control panel on which is mounted a Tirill regulator. The next three panels are for the main generating units, and the last panel controls the transmission lines. The switchboard occupies the space between two steel columns at the exact center of the building. Before it is the 4 ft. balcony extending out into the main bay on which the switchboard operator stands and from which he can observe all parts of the building. Mounted upon the first two panels are the voltmeters and ammeters, and a double pole, single throw main line exciter switch. On the third panel is mounted the Tirill regulator which derives its operating current from potential transformers in the 66,000 volt bus lines. The generator panels are each equipped with one ammeter and three point switch, one recording polyphase wattmeter, one integrating polyphase wattmeter, one frequency indicator, one power factor meter and the control handles to operate the remote control generator and transformer oil circuit breakers.

On the lower part of these panels is a time limit relay to operate on the aforesaid circuit breakers. The transmission line panel is equipped with the controlling apparatus to trip the 66,000 volt circuit breakers. These switches are, however, set by hand. At one end of the switchboard, and in the rear of it is placed the extra panel on which are mounted double throw switches controlling the 14 station lighting and outlying building circuits, the reservoir indicators and bell and signal circuits. To the left of the switchboard in the telephone room are four circuits coming from the outside. Mounted on a steel frame is a telephone switchboard equipped with 12 d.p.d.t. and 7 d.p.s.t. knife switches and the proper connections to the various circuits. There is also an extension connection from the telephone room running through conduit to a point in the floor directly in front of the switchboard. This is so that the switchboard operator may have a telephone with him at all times which he can plug into the floor receptacle, and enables him to have telephone conversation without leaving his switchboard. The telephone lines on entering the rear wall of the building pass to fuses and G. E. type Y 108 Form B telephone transformers. These have a ratio 1 to 1 and are tested to 25,000 volts.

On the third gallery or floor directly above the transformers, as before stated, are mounted the generator circuit breakers. These switches are General Electric Type K4. They are 3-pole, single throw, oil immersed and are solenoid operated and tripped. They are mounted in concrete cells. The disconnecting switches are placed between the generator and transformer circuit breakers, and also an equalizing bus.

In operation, current passes through the generator K4 circuit breaker, thence through two sets of disconnecting switches, which are mounted in their respective concrete cells and thence through the transformer K4 circuit breaker to the transformer. The equalizing bus connection is taken off between the two sets of disconnecting switches already mentioned and has in its own line a set of disconnecting switches. There are 4 of these sets of circuit breakers and disconnecting switches in their respective concrete compartments. The equalizing bus extends the length of the building directly in the rear of the four sets and consists of 600,000 c.m. muslin covered cable placed in Orangeburg fibre which in turn is embedded in a concrete wall. The switch sets are placed directly over their respective transformers and in all cases offer the shortest distance between generator and switch, and switch and transformer. While they are near to the switchboard so that in case of trouble they can be easily and freely reached they are entirely out of the way of unauthorized persons who might be wandering around the station and accidentally come in contact with a live part.



High Tension Switch Gallery, Showing Oil Circuit Breakers on Outgoing Lines in Foreground and Disconnecting Switches Overhead.

Low Tension Switch Gallery, Showing Generator and Transformer Switch Cells on Right and High Tension Switches on Left.

Station Circuits.

The high tension 60,000 volt circuit breakers are mounted on the second or switchboard floor but occupy a space in the rear of the switchboard and transformer compartments and extending the entire length of the building. There are four sets of three single pole circuit breakers for the transformers and three sets of three single pole circuit breakers for the three outgoing transmission lines. There are two sets of high tension bus lines which are suspended from the main roof trusses of the building, being fastened to two section Locke suspension insulators. The circuits are arranged so that current passes from the transformer directly into its oil circuit breaker, thence through two sets of disconnecting switches to the two bus lines. Outgoing current passes from the two bus lines through two sets of disconnecting switches, thence joining and through the outgoing oil circuit breakers, thence through another set of disconnecting switches, a high tension ammeter, and choke coils, into the line.

Great care has been taken in arranging this section to prevent the possibility of confusion in a time of trouble or of accident of any kind, which may arise, and the arrangement has been made just as nearly foolproof as it is possible to do so with such an elaboration of connections. The transformer circuit breakers are placed against the wall adjacent to their respective transformers. The line circuit breakers are placed on the other side of the room against the wall directly below their respective lines. The disconnecting switches are placed in two lines throughout the length of the room, being hung from steel channels, supported from the stiffening trusses of the building and are placed horizontally. The disconnecting switches for the outgoing lines are placed on one line. Those on the transformer circuit breakers are placed on another line and in all cases these switches are directly above their respective oil switches. The horizontal arrangement of these switches was made for the purpose of simplicity and safety of operation as there is nothing beneath them to interfere in any way in operating them. To prevent the possible danger of their falling out in case the switch jaws should become loosened, a device designed for this installation has been placed on the clip which automatically locks the bar with a latch when the switch is closed. The act of pulling the switch open, automatically opens the latch, the two actions being made at the same instant. This device, while simple is positive and prevents the possibility of serious trouble.

The high tension circuit breakers are General Electric Type K10. The disconnecting switches are of the same make and of the standard type, mounted on porcelain columns. All wiring is done with ¾ in. copper tubing to prevent corona, and reduce the danger of short circuiting between lines. Throughout, a consistent distance between wires has been maintained of 3 ft. and between any wire and any ground of 2 ft. In case of a short circuit in the high tension wire the greatest damage that could probably be done would be the shutting down of the plant, as there is absolutely nothing to burn. There are no barriers or cells of any description in the high tension work.

Contrary to past practice in California the wires leaving the building do not pass through windows or openings but through the center of a Locke wall insulator. This insulator was designed for this plant and consists of an 18 in. wall insulator in which is cemented a 3 in. glazed porcelain tube 3 ft. long. The conductor through the insulator is a piece of brass tubing threaded at each end and supplied with lock nuts and connectors.

In order that these insulators could be mounted in the steel and concrete wall cheaply and also in such a manner that the insulators could be easily removed without breaking or damaging the wall, a simple device was adopted. A circular opening was left in the steel reinforcement, slightly smaller than the insulator. Fastened to this on the outside was a ring made of thin galvanized iron, having a diameter slightly in excess of that of the insulator, and a width of 1½ in. This served as a socket in which the insulator could be placed. The concrete was then applied to the reinforcement, and a tight joint made around the sheet iron ring. After the insulator is placed in the wall a ring made of common ½ in. round iron of a size to just slip within the sheet iron ring is placed against the insulator, and this ring is in turn held in place by four wrought iron clamps which are held by ½ in. bolts permanently placed in the wall outside of the sheet iron ring. Should an insulator be broken, it may be removed from the outside by simply loosening the four nuts holding the clamps, which hold the movable ring, and a new insulator may be immediately inserted, and fastened. The circuit after passing through these insulators is carried directly to the pole structures of the various lines which are equipped with General Electric aluminum cell lighting arresters. These are placed in a small steel and concrete building about 100 ft. to the rear of the power station, and consist of horn gaps mounted on structural frame, and aluminum cells immersed in oil.

Station Wiring.

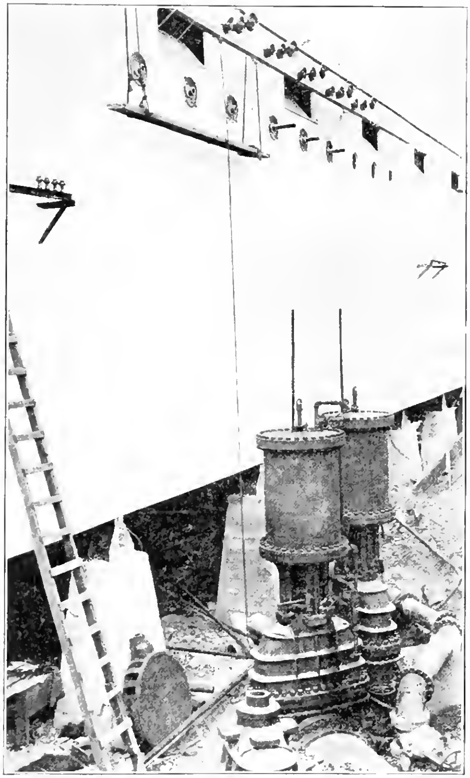
All operating connections between the high and low tension circuit breakers and the switchboard; also telephone wires, reservoir signal wires and lighting wires are carried in the concrete floors in galvanized steel duct. Provision is made for lights at every point of the building where it might be necessary to use a light either continuously or on occasion. The main bay is illuminated from six, four-light tungsten clusters, mounted on the lower chord of the roof trusses. The high tension compartments are similarly lighted with two lamp clusters.

Poles.

All high tension lines and connections outside of the building are mounted on reinforced concrete poles. These poles vary in length from 30 to 50 ft., as to their requirement. They are square in section with a minimum width at the top of 8 in. and a width at the bottom of 14 in. in the highest poles. They are reinforced with round steel rods and were made at the point of erection.

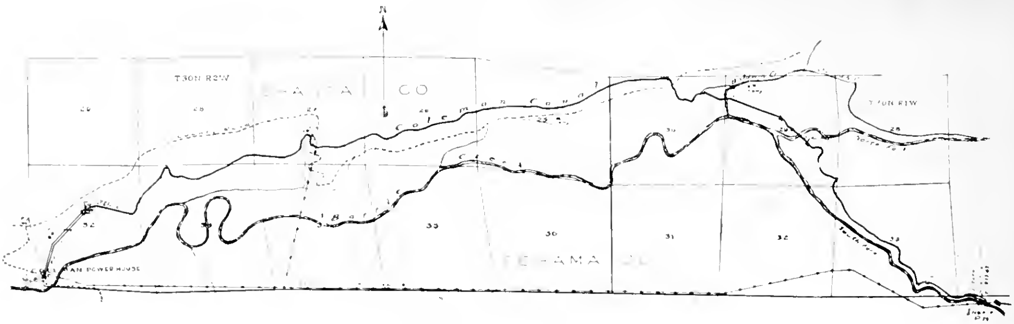
Tunnel.

As already stated there is a tunnel under the main floor of the building, which extends through its length. The floor over this tunnel is designed to carry the heaviest load which could be applied, and is 12 in. thick, and reinforced with triangle mesh steel fabric. There are two man holes corresponding with man holes in the transformer oil tanks, and one large opening made of steel shapes. A part of this opening is covered with a grating which gives ventilation to the tunnel and the remainder is covered with heavily trussed steel plates. The opening is of sufficient size that a transformer may be lowered through it, for the purpose of removing the core, by means of the traveling crane. All electric power conduits are placed in this floor. In the tunnel there are two transformer oil



Rear of Power House, Showing Wall Insulators of Outgoing High Tension Lines and Main 48 in. Hydraulic Gate Valves.

storage tanks. These are each 6 ft. in diameter, 16 ft. long, and will hold a quantity of oil somewhat in excess of that used in one of the raising transformers. The piping system between these tanks and the transformers is extensive and will allow oil to be circulated from any transformer to either tank; from one tank to the other; from either tank through the filter to any transformer or to a point outside of the building, or from one tank through the filter to the other tank. The movement of oil may be accomplished either by applying compressed air to the tanks or by means of a motor driven oil pump on the oil filter. This system allows, not only of filtering the oil, but of



Map of Coleman System.

preserving it in case it were necessary to empty a transformer following a burn out, and immediately fill a transformer with clean spare oil.

There is also, in the tunnel another system of oil piping. Oil is taken from the pressure tank which is supplied by the governor oil pumps already described. It is carried in 2 in. galvanized steel pipes and distributed to the five water wheel governors. The return from the governors is carried in 3 in. pipes and is brought to a rectangular sheet steel tank placed on the floor of the tunnel. This tank acts as a sump from which the governor pumps draw their oil supply.

There are also in the tunnel four systems of water piping aside from the main water wheel supply pipes, and the compressed air pipes. The first of these systems of water piping takes the supply from the exciter supply pipes and after passing through a pressure reducer supplies the cooling water for the transformers, and all other purposes for which water is used in and about the power house. The second system takes its supply from each of the main water wheel feeder pipes and is used for the purpose of filling the draft tubes before the water wheel is started in operation. The third system takes its supply from each of the main pipe lines back of the hydraulic gates and through a manifold, supplies water under full pressure head to operate the relief valves on the main water wheels. The fourth system supplies cooling water for the generator bearings, and is taken from the house system. All this piping is arranged to be free of access at all times. The tunnel is ventilated and drained at several points.

The construction work on the Coleman system has been carried out entirely by the company's own corps of engineers, with the exception of a small part of the canal which was built under force account contract. The work of this section has been under the general charge of Mr. Edward Whaley. The construction of the power house has been in charge of Mr. Perry O. Crawford, and the work designed by the writer who has acted as consulting engineer for the company. The time of construction from the letting of contracts for machinery to the completion and commencement of operation, has occupied one year and five months, which, considering the magnitude of the work should be recognized as a creditable record.

LOS ANGELES NEWS LETTER.

The opening meeting of the Los Angeles Section of the American Institute of Electrical Engineers was addressed by Dr. J. A. B. Scherer, president of Throop Polytechnic Institute, and Mr. George A. Damon, dean of the same institution, at Hamburger's Cafe, on October 17th. The meeting was presided over by Mr. O. H. Ensign, with about 130 in attendance. Mr. Ensign named the chairman of the different committees for the coming year as follows: Papers Committee, Prof. R. W. Sorensen of Throop Polytechnic Institute; Discussions Committee, Mr. C. E. Hogle, of the U. S. Reclamation Service; Membership Committee, Mr. J. E. Barker of the Los Angeles Aqueduct; Entertainment Committee, Mr. A. Kean of the Pacific Electric Railway. The executive committee consists of O. H. Ensign, chairman; E. R. Northmare, secretary; C. G. Pyle, assistant secretary; J. A. Liththipe, E. F. Scattergood, J. E. McDonald, and R. H. Manahan. Regular meetings will be continued throughout the winter on the third Tuesday of each month, to which all visiting engineers are cordially invited.

The contract has been let for the street lighting at Pasadena, on Orange Grove avenue. There will be over 200 solid bronze ornamental posts, costing approximately $100 each. This work is being installed by the Southern California Electric Company, of Los Angeles, at a contract price of approximately $35,000. Both of the telephone companies, the Edison Company and the municipal plant, are preparing to remove all overhead wires and service connections on this street.

The municipal plant at Glendale, California, will within the next thirty days extend their lines for street lighting and service connections into West Glendale and Tropico. Plans and specifications are being drawn for about a mile of ornamental street lighting work and an underground system on the main streets in Glendale.

The city engineer of Redlands, California is again drawing specification covering a system of ornamental street lighting throughout the business section.

The Home Telephone & Telegraph Company of Los Angeles are contemplating building two or three new sub-stations in the city during the coming year, together with other improvements, at an approximate cost of $350,000.

PRIMER OF APPLIED THERMODYNAMICS.[1]

TENTH LECTURE.

Elements of Forced Draft.

Years ago Gallileo, an eminent scientist of Italy, and the first inventor of the telescope, climbed the historic "leaning tower of Pisa" and by dropping cannon balls of different sizes and weights from the top of the tower found that all fell to the ground in an equal time interval. This can mean but one thing; namely, that no matter what the size or weight of a body may be, the velocity acquired in falling at a given place through a given distance is identical in each case, and is independent of the weight of the body. Hence it is seen that the height through which the body is to fall is the essential factor entering into the computation of velocity. It is found in elementary mechanics that this velocity is computed from the simple relation

$$v = \sqrt{2gh}$$

in which v is the velocity in ft. per sec., g is the so-called gravitation constant usually taken at 32.16, and h is the head or height through which the body falls.

Now let us take a column of water h ft. in height as shown in Fig. 23. It is evident that on the bottom

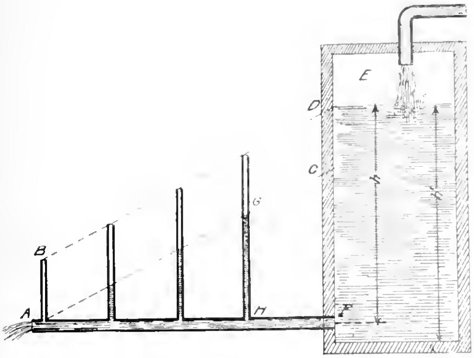


Fig. 23. Water Analogy of Friction Loss in Pipes.

of the tank there would be a pressure over every square foot of surface in amount equal to the weight of h × 1 cubic foot of water. If then d is the weight of 1 cubic foot of water the pressure per square foot is equal to

$$p_1 = h d$$

If now we fill the entire enclosure with a gas—say air for example— and can measure the pressure, we can apply our formula if we know the density or weight of the gas per cubic foot. In other words, we can at once compute h which is from the above.

$$h = \frac{p_1}{d}$$

Hence we make at once a formula for the flow of gases under pressure

$$v = \sqrt{2gh} = \sqrt{2g\frac{p_1}{d}}$$

This is a most important relationship for it can at once be applied to steam turbine velocity computation and also to computation relating to the air compressor. For instance, dry air at 50° F. has a density of 0.0779 lb. Consequently if we take air at ordinary pressure of (14.7 × 144) lb. per square foot and let it flow into a vacuum, we get an enormous velocity.

$$v = \sqrt{2g\frac{p_1}{d}} = \sqrt{\frac{2 \cdot 32.16 \cdot 14.7 \cdot 144}{0.0779}} = 1321.7 \text{ ft per sec.}$$

We have perviously found, however, that there is a most important relationship connecting the pressure, volume and temperature of gases which is symbolically expressed as

$$pv = RT$$

where p is the pressure in lb. per square foot v is cubic feet in 1 lb. of gas, R is constant, and T the absolute temperature. Since density is the weight per cubic foot of a gas, we have the important relationship

$$d = \frac{1}{v} \text{ or } d = \frac{p}{RT}$$

Hence we can determine at once the density of the gas under consideration for any pressure and temperature, and having computed this, we then find its velocity of efflux by substituting in the formula

$$v = \sqrt{2g\frac{p_1}{d}} = \sqrt{\frac{2gp_1 RT}{p}}$$

We must, however, be careful in substituting the correct value of p_1 in the last formula by remembering that this p_1 is the difference in pressure between the compressed gas and the outer air or chamber into which the gas discharges, while p is the absolute pressure of the gas under compression. A single example will suffice to illustrate this. Let us find from the above formula the velocity of dry air of 50° F., escaping into the atmosphere through any shaped orifice in any pipe or reservoir, in which the pressure is 4 oz. above the outside atmospheric pressure. Here we have $g = 32.16$, $p_1 = \frac{4}{16}$ lb. per square foot, $R = 53.37$, $T = 459.4 + 50$, $p = 14.7 + \frac{4}{16}$. Hence substituting we have

$$v = \sqrt{\frac{2gp_1 RT}{p}} = \sqrt{\frac{2 \cdot 32.16 \cdot 0.25 \cdot 53.37 \cdot 509.4}{14.95}}$$

$= 171$ ft per sec.

The quantity in cubic feet per sec. of air or gas under a given pressure that will flow through an orifice is readily computed by multiplying this velocity by the effective area of the orifice in square feet. Thus

$$Q = av = a\sqrt{2g\frac{p}{d}} = a\sqrt{\frac{2gp_1 RT}{p}}$$

The effective area is obtained by multiplying the true area by a so-called coefficient of efflux. The form of the orifice through which the air passes under pressure has practically no effect upon the velocity, but the volume of air discharged is largely dependent

[1] A resume', devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Senior Mechanical Engineering students at the University of California.

upon the character of the opening. The coefficient of efflux and consequently the volume discharged may be greatly increased by proper design of the opening which should be of such form as will render easier the outflow of a fluid.

In round numbers the coefficient of efflux when the pressure differences are comparatively small, as in the case of a fan for mechanical draft, may be taken as follows:

For air orifice in a thin plate	0.56
For a rounded-off conical mouthpiece	0.98
For a short cylindrical pipe	0.75
For a conical pipe whose angle of convergence is about 6°	0.92

In the study of hydraulics, it has been determined that there is a certain loss of effective head due to the friction of water against the sides of the conducting medium. This loss in head is found to be very approximately proportional to the square of the velocity, to the length of the pipe, and inversely proportional to the diameter. Thus:

$$h^1 = f\frac{l}{d} \times \frac{v^2}{2g}$$

in which f = coefficient of resistance of friction, determined by experiment.
- l = length of pipe in feet.
- d = diameter of pipe in feet.
- v = velocity in feet per second.
- g = acceleration due to gravity = 32.16.

For air in galvanized iron, carefully made and erected with all internal laps extending in the direction of air movement, by experiment f has been found to have a value of 0.039, while for water flowing in pipes, it has an average value of 0.02. The value of f, however, is not an exact constant. In the investigations of Unwin, it was found that $f = C\left(1 + \frac{36}{10d}\right)$ It is evident that this difference for f is very slight for pipes of large diameters.

We are now ready to see at a glance how the formula for chimney design with varying altitude above sea-level assumed in the last lecture can readily be determined.

$$\text{Thus since } h = f\frac{l}{d} \times \frac{v^2}{2g} \text{ and } h^1 = \frac{p}{D}$$

$$\text{we have } p = f\frac{l}{d} \times \frac{v^2}{2g} \times D = C\left(1 + \frac{36}{10d}\right)\frac{l}{d} \cdot \frac{v^2}{2g} \cdot D$$

$$\text{or } p = B\left(1 + \frac{3.6}{d}\right)\frac{l}{d} \cdot v^2 D, \text{ where } B = \frac{C}{2g}$$

$$\text{weight} = W = q \times D = a \cdot Dv = \frac{\pi d^2}{4} v D.$$

$$\text{or } v = \frac{W \times 4}{\pi d^2 D}$$

$$v^2 = \frac{W^2 \times 16}{\pi^2 d^4 D^2} = C_1 \frac{W^2}{d^4 D^2}, \text{ where } C_1 = \frac{16}{\pi^2}$$

$$\text{Hence substituting, } p = C\left(1 + \frac{3.6}{d}\right)\frac{l}{d} \times \frac{C_1 W^2 D}{d^4 D^2}$$

$$= C C_1\left(1 + \frac{3.6}{d}\right)\frac{l W^2}{d^5 D}$$

or solving for W we have

$$W^2 = \frac{pDd^5}{CC_1\left(1 + \frac{3.6}{d}\right)l}$$

$$\text{or } W = K\left[\frac{pDd^5}{\left(1 + \frac{3.6}{d}\right)l}\right]^{\frac{1}{2}} \text{ where } K = \sqrt{\frac{1}{CC_1}}$$

The constant K has a value of 87 for steam and 64 for air. In this formula W is the flow in lb. per min., p is the difference in pressure between ends of the pipe under consideration in lb. per sq. in., D is the density or weight in lb. per cubic feet, d is the diameter of pipe in inches, l is the length of pipe in feet.

When steam flows out into the atmosphere an approximate formula known as Napier's formula is very convenient in computation. $W = \frac{6}{7} p\, a$, in which p is the absolute pressure in lb. per square inch, and a is the area of orifice in square inches.

Let us now turn our attention to the question of mechanical draft. Primarily introduced for the purpose of increasing the rate of combustion, artificial draft was designated as "forced draft," its field of application being considered to begin where that of the chimney ended. By later refinements it has, however, become not only a means of assisting chimney draft, and of producing the conditions requisite to accelerated combustion, but it is now in many cases accepted as a convenient and efficient substitute for the chimney under all ordinary conditions.

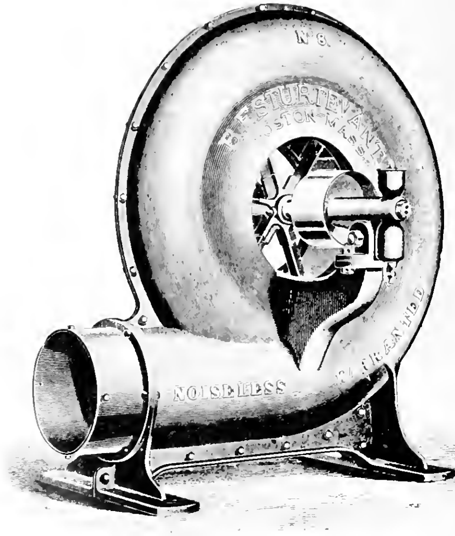


Fig. 24. Mechanical Draft Blower.

In Fig. 24 will be seen a typical example of a blower used in the production of mechanical draft. In this illustration is seen a steel pressure blower manufactured by the Sturtevant Company of Boston, Massachusetts. This type of fan, as its name indicates,

is a pressure blower rather than a volume blower. That is, the wheel is of such dimensions as to make it possible to deliver a comparatively small amount of air under high pressure. Other designs are of course made by this company and other manufacturers to meet the opposite condition, or large volume of air delivered under low pressure.

It is interesting to look into some of the fundamental equations of forced draft in order to get an idea of economy in installation. From fundamental mechanics we learn that energy is found in nature in two forms, kinetic and potential. Energy of life or motion described by the Romans as "vis viva" is expressed mathematically as the mass of a moving body multiplied by ½ the square of its velocity in symbols is $\frac{W v^2}{2g}$. Again a body may not have motion at all and yet possess energy. Thus a stone on a high hill possesses energy from its very position for if unbalanced in its high position it may at any moment descend great distances and do work. The hammer of a pile-driver lifted to its upper limit possesses this potential energy and the next instant this potential energy is converted into kinetic energy. Potential energy is mathematically expressed as the product of the weight of a body and its height above the lower plane of descent, or W h.

In considering the theory of mechanical draft let us derive some fundamental equations by putting the kinetic energy of the entering air or gas as equal to the potential energy it must possess in order to perform its work. Thus we have

$$\frac{W v^2}{2g} = W h, \text{ but } p = h\ d, \text{ or } h = \frac{p}{d}$$

Hence cancelling out and substituting, we have

$$\therefore p = \frac{v^2 d}{2g}$$

Where p = pressure in lb. per sq. ft.
d = density or weight per cubic foot.
g = gravity constant or 32.16.

Since power is the time rate of doing work, if we have a fan moving at a peripheral speed of v ft. per sec. against a total pressure of a p lb., then the fan performs a p v ft. lb. per second. Denoting Power by P and substituting for p from the above equation

$$P = a\,v \times \frac{v^2 d}{2g} = \frac{d\,a\,v^3}{2g}$$

From these equations we see the important laws in mechanical draft design; namely, the pressure given out by the fan varies as the square, while the power required varies as the cube of the velocity. This is very important to remember in picking a fan to perform given conditions in chimney draft, for by simply doubling the velocity, eight times the power will be required.

It will be instructive to illustrate this by solving a particular installation. Let us suppose that in a power house we need for proper combustion of the fuel, 15,000 cu. ft. of air per min. at a draft pressure of 1.25 oz. Upon investigation we find two mechanical draft apparatus offered. One has a diameter of 30 in., gives a pressure of 1 oz. at 740 revs. per min. and forces 405 cu. ft. per min., requiring 0.16 h.p. per inch of width of blade installed. The second fan has a diameter of 54 in., gives a pressure of 1 oz. at 410 revs. per min. and forces 726 cu. ft. per min., requiring 0.29 h.p. per inch of width of blade installed. Let us compute the widths required and the power in each case.

Let

p_1, v_1 = pressure and velocity necessary to produce required chimney draft, first case.
p_2, v_2 = pressure and velocity necessary to produce required chimney draft, second case.
p_3, v_3 = pressure and velocity of first machine at given rating.
p_4, v_4 = pressure and velocity of second machine at given rating.
Since diam. = 30 in. and r.p.m. = 740

$$\therefore v_3 = 3.1416 \times d \times 740 = \frac{3.1416 \times 30 \times 740}{12} = 5815 \text{ ft. per min.}$$

$$v_4 = \frac{3.1416 \times 54 \times 410}{12} = 5790 \text{ ft. per min}$$

$$p = \frac{v^2 d}{2g} \text{ or } \frac{p_1}{p_3} = \frac{\frac{v_1^2 d}{2g}}{\frac{v_3^2 d}{2g}} = \frac{v_1^2}{v_3^2}$$

$$\frac{p_2}{p_4} = \frac{v_2^2}{v_4^2}$$

substituting

$$\frac{1.25}{1.00} = \frac{v_1^2}{(5815)^2} \text{ or } v_1 = 5815\sqrt{\frac{1.25}{1.00}} = 6500 \text{ ft. per min.}$$

$$\frac{1.25}{1.00} = \frac{v_2^2}{(5790)^2} \text{ or } v_2 = 5790\sqrt{\frac{1.25}{1.00}} = 6470 \text{ ft. per min.}$$

Similarly, where q is total quantity of air per min.

$q = av$

or

$$\frac{q_1}{q_3} = \frac{av_1}{av_3} = \frac{v_1}{v_3}$$

$$\therefore q_1 = q_3 \frac{v_1}{v_3} = 405 \times \frac{6500}{5815} = 453 \text{ per in. of width.}$$

$$q_2 = q_4 \frac{v_2}{v_4} = 726 \times \frac{6470}{5790} = 811 \text{ per in. of width.}$$

$$\text{Hence width of first fan is } \frac{15000}{453} = 33.4 \text{ in.}$$

$$\text{width of second fan is } \frac{15000}{811} = 18.5 \text{ in.}$$

$$\text{Power required first fan } P_1 = 33.4 \times \left(\frac{6500}{5815}\right)^3 \times 0.16 = 7.49 \text{ h.p.}$$

$$\text{Power required second fan } P_2 = 18.5 \times \left(\frac{6470}{5790}\right)^3 \times 0.29 = 7.48 \text{ h.p.}$$

Hence it is seen in this case that the powers required are practically the same, although the sizes of apparatus vary considerably.

Many times short chimneys are used and mechanical draft apparatus installed, consisting of either an exhaust fan in the smoke flue or a mechanical or steam-jet blower underneath the grate bars. An INDUCED

DRAFT is produced by the former and a FORCED DRAFT by the latter. The advisability of installing mechanical draft apparatus is dependent upon the results of an economical comparison with the saving resulting from the lessened necessary height of the chimney and the useful results or saving accomplished by installation of an economizer in the stack which materially reduces the stack temperatures, thus lessening the natural draft.

THERMOTWISTERS.

1. Allowing for an efficiency of 75 per cent, what is the power required to drive a mechanical draft fan with a rounded-off conical mouthpiece 7 in. in diameter which delivers air at 2 oz. pressure with a velocity of 86 ft. per sec?

2. If the diameter of the above fan is 27 in., what is the number of revs. per min. it undergoes?

3. Air is driven through a pipe 12 in. in diam. 2000 ft. long. The difference in pressure between the two ends is 4 oz. How many lb. of air are delivered per min. and what is the velocity of the air and the horsepower required?

Solution of Thermotwisters—Seventh Lecture.

1. Steam at 100 lb. pressure is mixed with water at 100° F. The weight of the water increases from 10 to 11 lb. and its temperature rises to 197½° F. What is the percentage of dryness of the steam?

From steam tables for 100 lb. pressure I find
$h_0 = 298.5$, $L_0 = 887.6$, $W = 1$, $w = 10$, $h = 68$, $h_1 = 165.6$
We have

$$x_0 = \frac{h_1 (w + W) - wh + Wh_0}{Wh_0}$$

Substituting

$$X_0 = \frac{165.6\,(10 + 1) - 10 \times 68 + 1 \times 298.5}{1 \times 887.6} = \frac{843.1}{887.6} = 0.95$$

2. The same steam is condensed in and discharged from a coil, its temperature becoming 210°, and 10 lb. of surrounding water rise in temperature from 100° to 201¼°. Find the quality of the steam.

On page 356, we have for the surface condensing calorimeter

$$X_0 = \frac{wh_1 + Wh_2 - wh - Wh_0}{WL}$$

and from tables we find
$h_1 = 172.45$, $h_2 = 178.3$, $h = 68$, $h_0 = 298.5$, $L_0 = 887.6$.
Substituting, we have

$$X_0 = \frac{10 \times 172.45 + 1 \times 178.3 - 10 \times 68 - 1 \times 298.5}{1 \times 887.6} = \frac{924.3}{887.6} = 1.041 \quad \text{Ans.}$$

Hence since factor is greater than unity the steam must have been superheated.

3. What is the maximum percentage of wetness that can be measured in a throttling calorimeter in steam at 100 lb. pressure, if the discharge pressure is 30 lb.?

There must be enough heat liberated from the moist steam to superheat or at least to evaporate all the moisture in the steam when it gets to the lower pressure by throttling.

$X_0L_0 + h =$ total heat in original steam.

$H = 1163.5$ B.t.u., or total heat required at lower pressure of 30 lb.

Hence

$X_0L_0 + h$ must equal 1163.5.
At 100 lb. press. abs. $L_0 = 887.6$ $h_0 = 298.5$.
$\therefore 887.6\,X_0 + 298.5 = 1163.5.$

or

$$X_0 = \frac{1163.5 - 298.5}{887.6} = \frac{865.0}{887.6} = 0.976. \quad \text{Ans.}$$

4. Steam at 100 lb. pressure has added to it from an external source 30 B.t.u. per pound. It is throttled to 30 lb. pressure, it's temperature becoming 270.3° F. What was the dryness?

On page 356, I find formula for added heat to be

$$X_0 = \frac{H + k\,(T - t) - h_0 - Q}{L_0}$$

From tables
$H = 1163.5$, $k = 0.48$, $T = 270.3$, $t = 250.3$, $h_0 = 298.5$, $L_0 = 887.6$.
Hence substituting

$$X_0 = \frac{1163.5 + 0.48\,(270.3 - 250.3) - 298.5 - 30}{887.6}$$

$$\therefore X_0 = \frac{855}{887.6} = 0.964. \quad \text{Ans.}$$

5. In the last problem, the added heat is from an electric current of 5 amperes provided for one minute, the voltage falling from 220 to 110. What was the amount of heat added and the percentage of dryness of the steam?

In lecture we find 1 B.t.u. = 17.59 watts per min.

$$\text{Avg. voltage applied} = \frac{220 + 110}{2} = 165.$$

Volts × amps. = 165 × 5 = 825 watts per min.

$$\frac{825}{17.59} = 46.9 \text{ B.t.u. Applied.} \quad \text{Ans.}$$

$$\therefore X_0 = \frac{1163.5 + 0.48\,(270.3 - 250.3) - 298.5 - 46.9}{887.6}$$

$$= \frac{838.1}{887.6} = 0.945. \quad \text{Ans.}$$

6. An engine consumes 10,000 lb. of dry steam per hour, the moisture having been completely eliminated by a receiver separator which at the end of one hour is found to contain 285 lb. of water. What was the dryness of the steam entering the separator?

Since 285 lb. of water was separated from 10,000 lb. of dry steam, the original weight was 10,285 lb.

$$\text{Hence dryness of steam} = \frac{10{,}000}{10{,}285} = 0.972. \quad \text{Ans.}$$

POLE-LINE TEST.

At the request of E. E. Burgess, assistant superintendent of the Central Oakland Light & Power Company, a number of those interested in pole line construction witnessed a demonstration of the Murray concrete base at the company's pole yards, on October 28th. The base consists of a 6 ft. concrete stubb, to which an ordinary 30 ft. pole is firmly bolted and is intended to obviate the rotting of the lower end of the pole which would otherwise be in direct contact with the earth. It can be used either for new lines or in replacing old lines. The test consisted in applying a measured pull and noting the ensuing deflection. All present were satisfied that its strength greatly exceeded any of the demands of the most extreme surface conditions.

NEW ELECTRIC COMPANY IN TOKYO.

The Japan Electric Light Company, of Tokyo, has been successfully floated. Subscriptions were closed on August 15. The number of shares applied for has reached 106,000, exceeding by 6000 the number offered. It will be remembered that this is the company which seeks to compete with the existing electric light undertaking in Tokyo.

CHARTS OF THE ATMOSPHERE.[1]

BY PROFESSOR ALEXANDER G. McADIE.

Readers of the Journal of Electricity, Power and Gas may not at first glance realize any possible connection between aviation and the general field of electricity and the distribution of electrical energy. As yet there have not been published any special articles describing in detail the electrical plant of a flying machine. Not yet has the art of aviation reached such a point, and yet it is undeniable that as the flying machine is developed there will be opportunity for the installation of electrical devices, both in the control of engines and in the determination of position and distance covered. Aside from the purely technical point of view our readers may in common with the rest of mankind have a general interest in the development of aviation, or in a broad sense the problem of transportation through the air. While much appears in the public press relating to the successful attempts of individual birdmen to perform certain feats, very little can be found regarding the genuinely scientific work which must underlie all sure progress. Professor Langley's paper on the Internal Work of the Wind was hardly noticed by the popular press and yet it is the very corner-stone of the modern science of heavier than air flying. Another epoch-making book of somewhat different character is this volume "Charts of the Atmosphere." It suggests to every meteorologist a somewhat similar book upon surface winds and ocean currents issued by Maury fifty years ago. The present volume however forces a recognition of even greater possibilities than the Navigational Charts promised; for while the ocean binds the nations, water is not man's natural environment and the air is. Man had sailed the seas for ages before the Physical Geography was written; but men are only now beginning to fly. And what the future holds for us no one can predict.

The charts in this volume are primarily designed for the use of aviators and aeronauts. So far as we know they are the first issued for this purpose. The results of the observations made for 20 years at the Blue Hill Observatory in exploring the air have been used to good advantage.

We notice at the outset the distinction between aeronauts and aviators, the former being balloon pilots and the latter pilots of flying machines heavier than air. Twenty-four charts are published, each accompanied with a page of explanatory text. The first chart gives relative height, atmospheric density and temperature. Heights are given only in English measures and it would be an improvement if in subsequent editions corresponding metric values were given.

[1]This review of Charts of the Atmosphere, by A. Lawrence Rotch and Andrew H. Palmer, 4to. 24 full page charts (John Wiley & Sons, New York, 1911), has been specially written for the Journal of Electricity, Power and Gas by permission of Professor Willis L. Moore, Chief U. S. Weather Bureau.

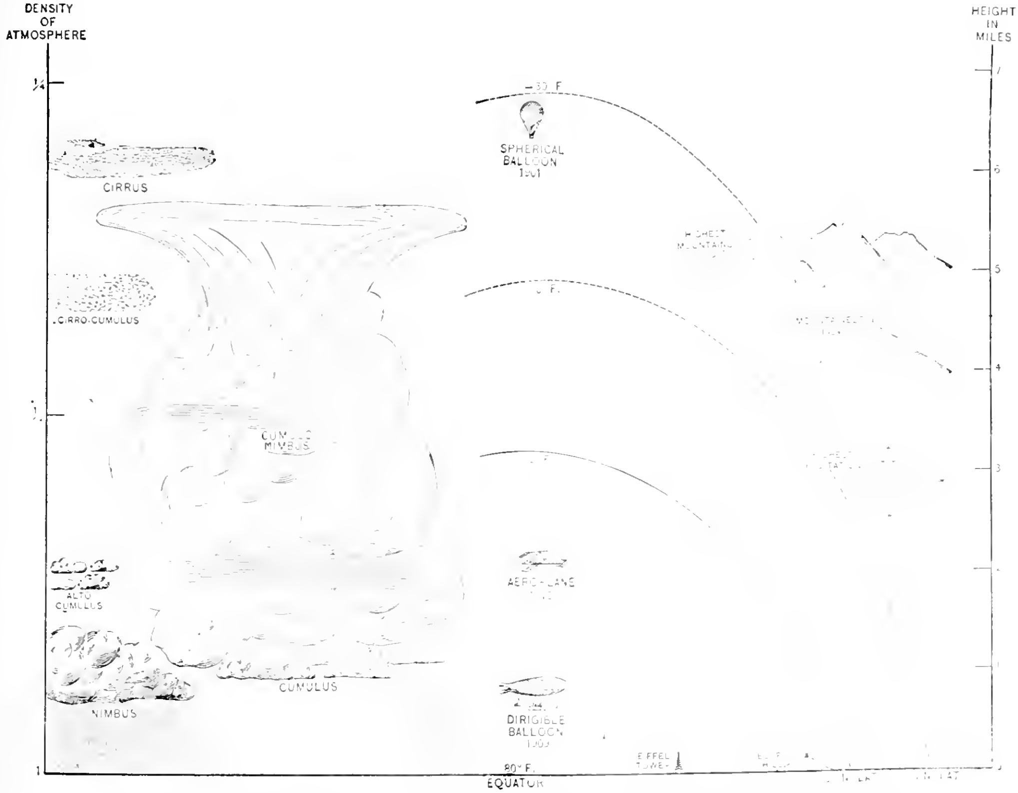


Chart No. 1. New Chart Graphically Showing Cloud Formation and Other Interesting Phenomena.

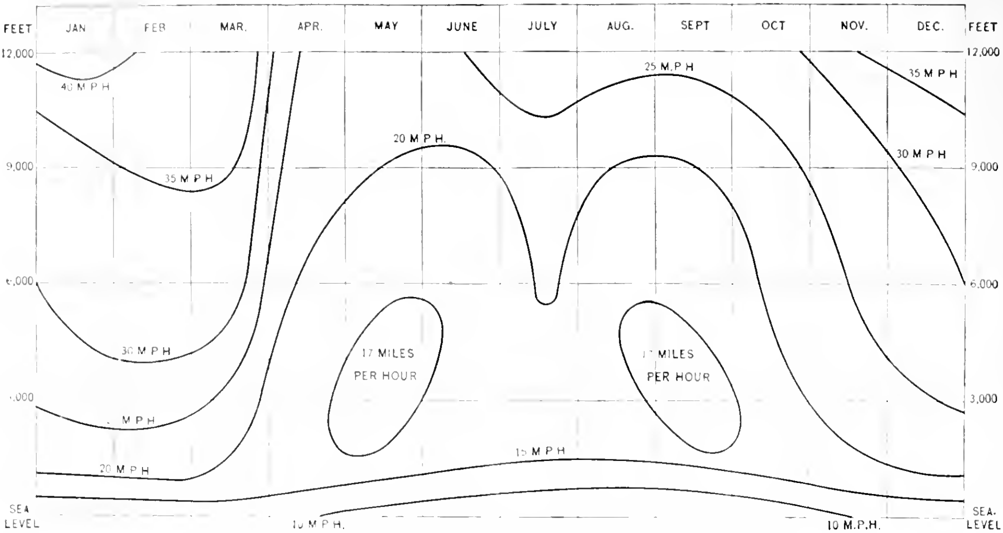


Chart No. 7. Monthly Variation of Wind Velocities at Blue Hill.

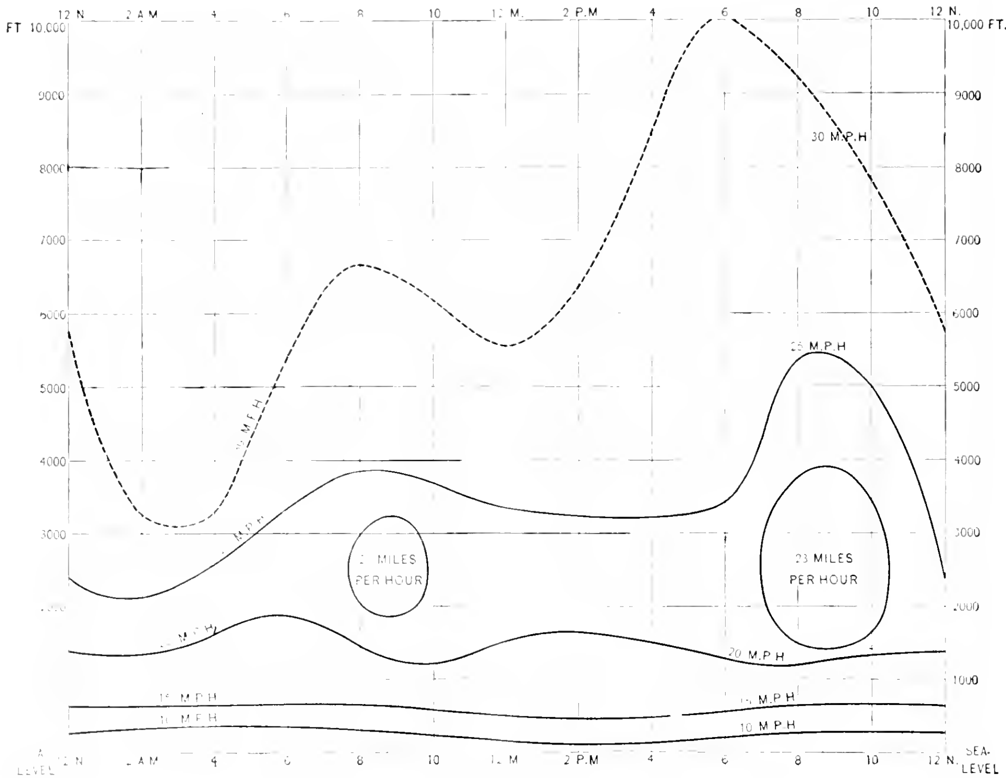


Chart No. 8. Hourly Wind Velocity Up to 10,000 Feet at Blue Hill.

Possibly a parallel column showing dynamic meters and equivalent pressures in millibars should be added. This opens up a matter of the utmost importance, namely, shall scientific units or units that at least make a pretense of precision be used now or shall we continue to use the old and cumbersome units and clumsy tables for conversion. This it seems to us is the only point on which the authors can be justly criticized. For in no place do they use anything but the old English units. Perhaps the authors felt that as the book was intended for American airmen, it was better to keep to the units in common use and that the introduction of absolute units would not be desirable at the present time. Mr. Rotch's work abroad however is so well known and his familiarity with kite and balloon data so great that it seems strange not to find incorporated in this work at least equivalent values in units that are comparable and have a scientific basis. And it is only a question of time before the new notation must be used, for the old units retard rather than make for progress. The arguments in favor of the new pressure unit; i. e., where the pressure is represented in units of force and the value of one million dynes taken as a standard and all pressure variations given in percentages of this are obvious, and the terms millibar, centibar and decibar instead of others are daily appearing in the literature of meteorology. Tables are already published for the quick conversion of geometric to dynamic values. The reason for introducing the dynamic meter is simply because the value of the acceleration of gravity varies. As Bjerknes pointed out in his recent Dynamic Meteorology the surface of equal heights is a slanting surface on which equilibrium is not possible under the sole action of gravity. On a surface of equal height above sea level a ball would roll from the pole to the equator and on a surface of equal depth below sea level it would roll from the equator to the pole. Therefore surfaces of equal height are not suitable as co-ordinate surfaces in problems connected with the dynamics of the atmosphere. To perform the same amount of work unit mass must be lifted higher at the equator than at the pole. The whole conception is interesting and an idea of its far-reaching consequences can be obtained by thinking of a dynamic map in which the height of a mountain would be measured not by the vertical distance from sea level to summit; but by the proper value of the work done in reaching the summit.

The text accompanying the various charts is well written. The diagrams are explained in an easy and natural way and there are many references to experimental facts which win and hold the interest of the lay reader. For the professional airman the charts are without question a "vade mecum." Of course the obvious weakness of all such charts from the professional air navigator's point of view is that they represent average conditions, which may not even be the probable conditions; and obviously they cannot be expected to meet the individual requirements. As Professor Rotch very wisely puts it:

"In the air as on the earth it is the unexpected which determines the result."

The charts are all valuable and are particularly strong in the matter of wind velocities at various levels, and the frequency of certain winds at certain seasons. Of course data are chiefly those relating to horizontal movements. Ascensional air currents and more especially the peculiar intermittent pulses which we do not yet adequately recognize nor automatically record are however not forgotten. In the text accompanying Chart 8 it is shown that intermittent ascending currents occurring during the day time are strongest in summer and when it seems to be nearly calm. The upper limit of these currents is usually shown by the tops of cumulus clouds in which descending currents may cause vortices about horizontal axes. Cumulus clouds therefore indicate "that although the horizontal velocity of the air below them is less than the average, the conditions are unfavorable for aerial experiments, especially near the clouds."

This we think is a matter of great importance to aviators and doubtless as the years go by we shall find that there are certain hours of the day or night when the conditions are favorable for aviation; and other periods when there will be an element of danger. The vertical stability of the air is greatest during the night.

Extremely interesting are Charts 21 and 22. The former enables the aerial navigator who has studied the pressure distribution from the daily weather map to forecast the changes of wind at different heights. In the case of low pressure areas the closer the isobars the stronger will be the wind and the more nearly parallel or concentric to them will be its direction, which turns to the right hand with increasing height in the front half of the low pressure and slightly to the left hand in the rear half. Chart 24 gives the aerial routes of the summer across the north Atlantic. Courses are indicated and appropriate lines show the distance travelled by each wind and the direction in which the airship must be headed to maintain the course; also the distances which the motor acting alone would drive it. These forces represented by the adjacent sides of a parallelogram give the resultant progress. This and the course to be steered are readily found by means of an instrument devised by Professor Rotch and constructed by Casella in London. When the wind and motor act together the resultant is their sum and when opposed, the difference. For simplicity the winds are concentrated in eight directions.

The work as a whole is a practical application of the knowledge deduced from many years' work at Blue Hill Observatory in the measurement of cloud heights and velocities, as well as other problems in meteorology which were not undertaken in connection with aerial navigation. The volume shows how valuable the work of the investigator becomes in directions never dreamed of when undertaken. The Observatory has thus furnished data of the greatest importance to aviators and aeronauts. The book marks an epoch in aerophysics. It is undoubtedly the forerunner of elaborate charts of the air, even as the Pilot Charts followed from Maury's work.

SOUTH AMERICAN ELECTRIC LINE AND DEVELOPMENT.

It is stated that the Hypothecary Bank of Uruguay will make loans in order to facilitate the colonization of large areas in the Departments of Rocha and Maldonado alongside the new electric railway, the construction of which will be initiated shortly.

RIGHT OF WAY AND LINE PROTECTION.

BY NORWOOD W. BROCKETT.

Transmission lines are generally constructed either under franchises upon roads and streets or upon property owned by the company or upon which it has an easement. An ordinary easement should give to the company the right to construct, maintain, renew and repair its transmission lines and if it reserves to the grantor the right to use the property, such right should be restricted to uses which will in no manner conflict with the use by the company. The principal objection to an easement lies in the fact that if the owner of the fee loses his property by tax foreclosure, the easement is wiped out, leaving the company without its right-of-way. In practice, this necessitates an investigation yearly of the taxes upon the property covered by easements.

Through the efforts of this Association, the 1909 Legislature granted to the electric light and power companies, a right-of-way one hundred feet in width through all State lands upon the payment of reasonable compensation for the property so taken.

A public service corporation is entitled to the same protection of its property under the law, as any individual. The principal damage to its lines is caused by trees and blasting along the right-of-way. In purchasing a right-of-way or obtaining an easement therefor, a clause should be inserted in the instrument giving to the company the perpetual right to cut down or trim, upon land contiguous to the right-of-way, all timber or underbrush, which, in the opinion of the company, are or may become a danger or menace to the maintenance of its lines.

In cases where the pole line is set along the edge of a county road under a franchise, a constant annoyance is caused by the interference from the branches of trees upon private property contiguous to the road. The company, under its franchise, has the right to occupy the position which it does. The owner of the property has a right to cultivate fruit and shade trees upon his own property and when these rights conflict, trouble follows. The writer has, upon various occasions successfully maintained the position that when the overhanging of trees upon the county road conflicted with the lawful easement granted by the Board of County Commissioners, that the trees became a nuisance and could be trimmed in such manner as not to interfere with the lines. However, if the poles are placed upon the extreme edge of the road and the cross arms and wires overhang the property, the company has no legal rights. Where poles are set in this way, an easement should be first obtained from the property owner, giving to the company the perpetual right to overhang his property. Every man has a right to use his property in any legal manner in which he sees fit, so long as he does not invade the rights of the owner of other property. An owner has a right to blast stumps from his land, but he has no right to blast them in such manner as to injure transmission lines and if he does so, he is liable in damages. The right to recover damages and the actual recovery thereof are, however, two different matters, as the blasting is generally done by some irresponsible contractor, against whom a judgment would be worthless. Patrol men should be instructed to keep a careful watch upon all operations in the clearing of land and special notices given them to serve upon all property owners about to blast along transmission lines, the notice reciting the danger to life and property in the event the line is broken. As a general rule the owner is reasonable in the matter and will blast at a certain time and in a certain manner. In the event he will not do so, the court will, upon a proper showing, grant an injunction restraining the owner from doing such blasting. In a suit for the collection of damages for the negligent breaking of a transmission line by blasting or otherwise, where the company has suffered considerable loss to its machinery and service, in addition to the time and material used in repairing the line, the question arises as to whether the person causing the damage could reasonably have anticipated that the mere breaking of the wires would have occasioned such a serious loss. To protect against this, the company should post a notice upon each pole, giving the voltage and stating concisely the danger to life and property which may be caused by the destruction of the lines. This notice should also state that the wires are absolutely safe, unless interferred with, so as not to alarm the public in emphasizing the danger. These notices also have considerable bearing in the case of injury to the public.

DISCUSSION PAPER ON PUBLIC SERVICE COMMISSIONS.

H. W. Crozier: How much control do you think the Commission would be able to exercise over the municipalities? Assuming, for instance, that it was a case of another company, not a municipality, but an ordinary organization going into the field as a competitor? Is it understood that the Commission could refuse permission to that competitor, or could allow both one and the other?

Max Thelen: That of course depends upon what view the legislature will take of the matter. A statute has to be drawn up before any of the provisions of the constitutional amendments will be effective; and I cannot say before hand whether the legislature will confer upon the State Commission the power and duty to pass on these new corporations or whether it will not.

H. W. Crozier: In the states of Massachusetts, Wisconsin and New York what about the power of a municipality to go into the business?

Max Thelen: In Wisconsin the municipalities have the power, and a great many do; in New York to a smaller degree, and in Massachusetts also to some degree; so in those states too we find quite often the situation in which you have a municipally owned plant and a privately owned plant operating in the same city.

H. W. Crozier: It has been admitted I believe (I am not sure of my point there) but it has been stated here in San Francisco that it will be absolutely necessary for us to purchase the Spring Valley Water Works before we can go into the water business—not so much that it is required by law, but as a matter of expediency. It seems to me that is a good provision, not to ruin the other man's property if the city were to go into the business itself.

The particular case I am driving at is where there is an electric light company which is giving excellent service, and the rates are low. For some reason or other the city wants to go into the business itself now. We all admit that it is proper they should buy the company out.

Max Thelen: I think that is a sensible thing to do.

H. W. Crozier: But apparently, as far as I can see, they are going into the business and compete with them like anyone else.

Max Thelen: I don't see how you can prevent that unless you take away from the city the power to own its own plant. If the cities are to have the right to own their own plants then of course there may be cases in which the cities themselves are unjust, and you are going to have unjust results to existing corporations, but I think you will find that the cities will generally acquire the existing plants.

H. W. Crozier: They have shown a tendency in some cases.

Max Thelen: They are contemplating that apparently in this city with the water.

W. G. Vincent, Jr.: May I ask if any of these Commissions set maximum rates or set rates? I think that would answer that question. If they set rates, they could prevent the municipality charging an unjustly low rate.

Max Thelen: In answer to your question, I would say there are some commissions that fix a maximum rate. For instance the Georgia Commission fixes maximum railroad rates; but the Commissions of Wisconsin, Texas, Massachusetts, fix the rate. Now I am afraid that you are laboring under a little misapprehension. If this constitutional amendment passes, the State Commission won't have the right to fix the rate of a municipally owned plant. I want to say this in all frankness. The amendment provides, at least by implication, that the State Commission shall not have power over a municipally owned plant. It says "Every private corporation," and by saying "Every private corporation" of course, by implication, that excludes a public corporation, a municipally owned corporation.

A Member: I would like to ask if in some of the Eastern States having public service commissions, if those commissions have the right to fix the rate on municipally owned plants?

Max Thelen: Some of them from Wisconsin have. I am not sure whether New York has; I don't think it has; but I know Wisconsin and Massachusetts have the right to fix rates. I think that Wisconsin and Massachusetts are the only two states in the Union that give to the State Commission the absolute power to regulate and control a municipally owned plant; but with that qualification Wisconsin permits the city authorities to do nearly everything they wish to do except to fix a rate, and what the municipalities do sticks unless there is an appeal to the State Commission. Matters of services and facilities are regulated by the city authorities, and the city ordinances on these matters prevail unless overruled on appeal to the State Commission.

F. F. Barbour: In regard to the indeterminate clause, in Wisconsin, if I am not mistaken, they allow corporations which have franchises to surrender their franchise, and come under the terms of that clause. Do you know what proportion of the corporations have done that?

Max Thelen: That statute was first passed in 1907, and the corporations were given one year, I think, within which to bring themselves under its terms, and surrender their franchises; and then another year, and another year, and that brings them up to the present year; and only 25 per cent have surrendered their franchises and brought themselves within the terms; but the last legislature took the bull by the horns, and declared all corporations subject to the new law with respect to the indeterminate franchise; so in Wisconsin every franchise is an indeterminate franchise. That operates very largely to the advantage of the existing corporations, and consequently none of them have complained. Of course the reason why the state wanted to do that was because the municipalities then acquired the right to purchase these companies at a valuation to be fixed by the Commission with an appeal to the courts.

S. B. Charters, Chairman: Is there any further discussion? I had hoped possibly we might have an expression of opinion from some of the corporation side of the house, that is, people who are going to be most directly and immediately affected by the rulings of any such commission as this is proposed to be.

I noted in the last Electrical World coming over tonight a few points in regard to the operation in Wisconsin. As the speaker said, the corporations were very much afraid, so to speak, of the operation of this Commission when it first took office; but since then the public opinion, and the opinion of the corporation people likewise, has practically entirely changed. The result has been in every way favorable to the corporations, that is, in this way, that unjust discrimination to a very large extent has been abolished, and there are corporations which had been forced by franchises and other powers conferred on the cities, to make unduly low rates. In such cases the Commissions raised them. Indeed it has been found that an efficient commission of this kind has been of benefit to everybody concerned. In the State of Wisconsin it has been found that the saving in railway fares would amount to a little over a million dollars a year, and the saving in freight rates is approximately $800,000; that is approximately two million dollars a year so far under the operation of the Commission saved to the people.

On the other hand, it has been found that the corporations have been given a much greater security in the eyes of the investing public. In a great many places there is to-day a feeling of distrust as to what the outcome is to be in regard to certain things, whether we may have cut-throat competition between various companies, and whether a municipality may come in and enter into competition with a corporation, reducing the value of its securities. Under those conditions there is a feeling of insecurity as to what the value of public securities should be. In almost every case the corporations in Wisconsin have not only shown an increased income, but they have also shown an increase in net profits, so we can see that it works both ways. There has been a saving to the people in actual rates in a great many cases; and owing to the increased security given the corporation a possible increase in income and net profits; so I think if we might hope to have a Commission which would operate as efficiently as in Wisconsin very favorable results might be achieved. Of course the whole thing hinges on the efficiency of the Commission which is appointed.

A. H. Halloran: All those present understand that the State Commission under discussion is something that is proposed; but going ahead on the assumption that this Commission is established I would like to know if the men interested in the Commission have any preliminary plan as to the method in which the work is to be done. Mr. Thelen has said there will be five Commissioners, and thinks there will also be a secretary. Now in regard to the engineers that are to do the work, and the various statisticians and evaluators, has any general scheme been mapped out as to the way in which they will tackle the various problems, the order in which the business will be taken up, and also in regard to the compensation which is to be paid?

Max Thelen: The Commission itself, as far as I know, has not made any general plan at all. I have a plan in my head, and if you gentlemen are interested I will give it for what it is worth, although I have absolutely no assurance that the Commission will adopt it.

There are to be five Commissioners and a Secretary. Of course there would be an administrative portion of the work, which would consist of the commissioners, the secretary, the stenographers and clerks. In addition to that there would be a rate department. There is one already consisting of a rate expert and three assistants. The rate expert gets $3,000 salary, and the assistants get a salary—I am not sure whether it is $2,000 or $2,400. Now in addition to that it will of course be necessary to have an engineering department.

That will be one of the most important departments of the Commission. The Commission has already selected its engineer. It was very fortunate in the selection. The Commission secured the services of R. A. Thompson, who was for nine years the engineer of the Texas Railroad Commission and as such made the valuation of the railroads in Texas. In addition to that he helped start the work of the Oklahoma Commission, and was highly recommended by Franklin K. Lane, of the Interstate Commerce Commission. He is a man who will give his entire time to the service—and I want to say that all the men employed by the Commission give their entire time to the work. Take my own case. When I was appointed I made up my mind that I would give every bit of time to the Commission; and that is the same with the engineer and with the other employees of the Commission. If this Commission is to do effective work a man must be "Johnny on the spot" all the time.

The engineer will have various functions to perform according to this mythical plan I have outlined. First he must make a physical valuation of the railroad properties in the State, and that function probably will extend later to public utilities, at least to such of the public utilities over which the Commission will have control.

The second branch of his work will consist in what we may term inspection work, that is, to inspect the physical properties of these corporations. Massachusetts, for instance, has ten inspectors whose sole duty it is to inspect the condition of the railways of the state—the electric railroads and the steam railroads, to inspect the tracks, the equipment and the engines. They go out whenever a complaint is made as to any of those matters and investigate the subject matter of the complaint. They go out whenever an accident takes place and investigate all the facts in connection with the accident, and make their recommendations as to how those accidents can be avoided in the future. That would be inspection work as applied to railroads.

Now, as applied to Gas, Electric Light and Telephone companies, I think we ought to follow as far as we can in the footsteps of Wisconsin. Wisconsin has divided the State into four sections, and in each there is a man who is an electrical inspector. He inspects the electrical plants, sees whether the voltage is kept up, sees whether the testing of the machines is accurate, and looks after plants in his district in matters of the service. Those men are out in the State all the time. They come in every month or two and have a powwow in the office, and go out again. There is a gas inspector who inspects all the gas corporations in the state. They have a telephone inspector also, and have done some very interesting work along those lines. He has made a test of 112 calls in each of a very large number of cities of the State in order to see how quickly Central answers, and the party is reached at the other end, how many times Central tells him that the line is busy or to call again; and these tests have been tabulated and sent to the Telephone corporations. Some of them had a good showing and others did not; and the result has been that those that did not have a good showing have been trying to improve. Mr. Thompson is a man who has done both kinds of work, that is, both physical valuation and inspection work.

In addition to that, under this plan of mine that I dream about once in a while there should be established here in this Commission a department of statistics and accounts, as they have in one or two of the leading states. Very few states have paid proper or sufficient attention to this matter of statistics and accounts. It would be the function of this department to examine all the reports which come in from the different railroads and public utilities, to see whether they are accurate or not. It would be the function of the department to establish a uniform system of accounting in so far as it could work in this state. The Constitution ever since 1879 has made it the duty of the Railroad Commission to establish a uniform system of accounts as to railroads; but I haven't been able to discover in any of the archives of the Commission that anything along those lines has ever been done. This department of statistics and accounts would be of great assistance to the Commission in case of a contest in rates, because that department would then be called upon to get the necessary statistical information for the Commission, and also in the matter of stocks and bond issues. It would be called upon to give the financial facts just as the engineering department would be called upon to give the physical facts. If we had those departments—the administrative department, the rate department, the engineering department and the department of statistics and accounts, with good men in charge, who would give all their time to it, and be "Johnny on the spot," I think the Commission ought to be able to do good work.

Now as to the question of salaries, the Commissioners are to get $6,000 apiece. New York pays $15,000, but that is exceptionally high. New Jersey pays $6,000, Massachusetts pays $6,000 to the chairman and $5,000 to the Commissioners, and Wisconsin pays $5,000. The rate expert, as I have said, gets $3,000; the secretary $3,000; the engineer $5,000, and we feel ourselves particularly fortunate in getting an engineer of Mr. Thompson's experience who will do the work for $5,000 a year for two years. As to the salary of the head of the department of statistics and accounts I suppose it would be about $3,000. That is what most of them receive throughout the country.

I want to say that this is all a plan running in my head, and has absolutely no official sanction, and can not tell whether the Commission will be disposed to take my view of these things or not.

C. L. Cory: There are one or two things that I think deserve some fuller discussion than they have had up to the present time. The first is in regard to the relations of a public service commission having to do with the control of a public utility, and a municipally operated public utility. Now the fact is that in the State of Wisconsin and in Massachusetts, and to a certain extent in New York, the municipally operated public utility is under exactly the same control as the private public utility. That brings me to another point. Much has been said in this general matter of the control of the public utilities regarding a uniform system of accounting. Now a uniform system of accounting as proposed by many of the Commissions I know as an absolute fact is impracticable. They are not any use. They have been discarded and not used by the corporations, for the very reason that those accounts do not conform either to the accounts required from the auditing department, or the accounts that are of most value from the standpoint of engineers, as most of us as engineers know. I personally believe, if I am able to read clearly the decisions of the good Commissions—and I want here to say without any hesitancy that there are good State Commissions for the control of public utilities, and there are some that do not deserve any adjective that we may with propriety use in an audience of this kind. We are all much given to thinking of the commission that has to do with the control of a public utility, whether it be a railroad or any other public utility, making that synonymous with the Wisconsin Commission. Would that it were so. You will find in the five volumes that have already been printed of the Wisconsin commission's proceedings not only a general discussion from the standpoint of equity, but concisely in the back of each of those volumes the specific decisions that have been rendered by the Commission and those are the valuable things; those are the things that unquestionably need to be taken into consideration when we are considering the problems of the control of public utilities. There is one point which has impressed itself upon me which I do not believe has ever been taken up by the public utility commissions. If it has I should be very glad to have Mr. Thelen tell us something about it, be-

cause he has had the opportunity recently of learning what has been done in many of the states—that is the labor problem. We are taking up now all over the United States the matter of the rates or the returns, the receipts of the public utility corporation. Unless I am very much mistaken the relation of the employer to the employed has absolutely been left to the employer. That problem has been left, unless I am very much mistaken, entirely to the corporations themselves. Their losses, the loss to the people, the loss to the laboring man, the loss to the employed, have been exceedingly great. I have had it suggested to me very recently that possibly the Public Service Commissions of the broadest type might assist materially in adjusting some of the difficulties, perhaps by arbitration between the employers and the employed. If that is possible, if it is not done at the present time, if it is possible to develop that in the future I think it will be distinctly constructive work.

There is one point I wish to mention. If it were not that we are here a group of engineers, and we have been complimented by one of our State officials in coming here to give us this discussion and valuable information, I should not mention it, but there is nothing gained by not being frank, and that is this: I believe it is true that the Commissions that do not deserve the commendation such as is given to Wisconsin and Massachusetts have been wrecked upon one rock, and that is the rock of politics. I do not believe that as engineers any of us will for one moment allow that any improvements in the science which has developed in engineering, that the growth of communities, that the value the public service corporations have given to communities, has ever been assisted by politics. I do not mean politics in the higher sense; I mean in the selfish sense. True, all facts must be obtained no matter what the result may be. I am inclined to think that some commissions, whether they be for the control of public utilities or Railroad Commissions or otherwise, might be of even less service to the community than the commission which consists entirely of gentlemen of leisure, and which employs a pretty—but very indiscreet stenographer. I think that a commission that is going to conduct this work as some of them have—purely on the basis of politics, and be controlled by politics, will not be constructive; they will not deserve the co-operation of engineers who, I believe, it will be found are as interested as any people in the development of the proper relation to the public utility corporation and the people.

I am glad Mr. Vincent brought up the point of the indeterminate term as regards franchises. As you know, we in this state have had considerable difficulty regarding the value of a franchise in valuing a property, and then immediately considering that franchise on a little different basis for taxation purposes. I think the time is come when we must cease indiscriminately terming something a franchise which as a matter of fact is nothing more or less than a permit. The permit given in the State of Wisconsin of course, as Mr. Thelen very clearly set forth, is to prevent unwise and expensive competition. That sort of thing is more or less like an exclusive franchise that does exist in some cases in cities and counties of California; but in general the public utilities other than the transportation companies that are said to possess a franchise do not in reality possess a franchise; they simply possess a permit; and another corporation can with the greatest readiness obtain a similar permit, and go into competition with the old corporation, and thereby entail upon the people in general a much greater expense than if one corporation were allowed to go ahead and that corporation properly controlled.

Of course I am not at all familiar with the proposed amendments. I think we are especially to be congratulated that Mr. Thelen has set forth some of the important points in these amendments; and we as voters are especially interested in that, and I should suppose a little more interested and a little more capable of appreciating what it will mean. I cannot quite see for myself, however, how a large public utility corporation which is doing business in a great many cities, and at the same time doing business in communities outside of the cities, can with any degree of success, be controlled by the different bodies. It happens that I personally have had to do within not very many years with the work incident to the adjustment of rates—one in regard to the Telephone company, the other with regard to the rates for electrical service in a small town. In each case we were confronted with this problem: the local business of the city in either case was but part of the main corporation. How is it possible, if you like to put it plainly, how is it possible for the City of San Francisco or the City of Los Angeles by any method, by any board of control, to adjust rates with the degree desirable if in that city there be a company which is not merely doing a local business in that city, but doing an extensive business in other cities as well? Of course that is clear to you because of our long distance transmission of power that often makes the case. Even with our gas utility the same is true; and of course as to the other utilities we again find the same difficulty. The areas that Mr. Thelen has drawn on the board showing the relative importance of the control of the State, as contrasted with the control of certain cities, does not quite satisfy me.

Max Thelen: I am willing to put the line anywhere; in fact I think it ought to be moved further up. I was using that as a matter of illustration. I think the triangle ought to be larger considerably as compared with the rest of the square.

C. L. Cory: As engineers we are very much inclined to deal with volumes rather than areas; and if we will take any division of that area that we have there, and consider the litigation and the cost to the consumer—I am willing to go back where we belong—the cost to the consumer of everything that is involved to adjust those rates, I think the form of the small area that might be put in that triangle would be greater than the volume that you might get in any other area; because how can we have two different bodies, with no co-operation of the one with the other, attempting to control a rate which is one which can only be controlled by a body large enough to cover the activities of the entire corporation.

Far be it from me to indicate that the proposed action is not very wise. We as engineers know that compromises are absolutely necessary. The problem that we can solve with the logarithm table or the stick is not worth while. We must deal with problems as a whole and with the ultimate result sought to be obtained, taking everything into consideration. But as an engineering problem, as a problem which particularly interests the engineer, and going back to the East, where we get out best advice and constructive work, I am somewhat skeptical about any method of control of rates where the matter is divided between a wise and well organized State Commission and another local body, no matter what it may be. As I say, I think we are extremely indebted to Mr. Thelen for coming here this evening; and in any capacity I think the Institute of Electrical engineers can assure him that any assistance that is possible, whether it be from those who are actively interested in the work of the corporations, or those that are not so directly interested, whatever may be for the building up of a wise and constructive commission, the development of a relation which shall be harmonious between the serving companies and the people to be served—not like he indicated in the case of the street railroads of New York City—but a wise co-operation, mutual respect, mutual confidence. I think he can be assured that all of us who are in the Institute and represent the Electrical interests, will be only too glad to do anything we can. (applause).

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CONTENTS

Charts of the Atmosphere

Elsewhere in these columns will be found a review written by Professor Alexander McAdie, of the U. S. Weather Service, on a recent publication entitled "Charts of the Atmosphere." The whole world stands awe-inspired with the gigantic strides being made in aeronautics. Awe-inspired for two reasons. First, the record-breaking sacrifice in life on the part of the pioneers in this science, and second the untold possibilities still to be accomplished make men bow their heads in silent recognition of the unfolding of the great designs of their Creator.

It is doubtful if ever an advance in scientific work was accomplished with such frightful loss of life. Daily the record of death solemnly tolls the treacheries encountered in hitherto unstudied air-currents.

Of material aid are charts that can foretell atmospheric conditions. For instance it has been found that intermittent ascending currents occur during the day time, being strongest in summer and in nearly calm weather. Their upper limit is usually shown by the tops of cumulus clouds in which descending currents may cause vortices about horizontal axes. Cumulus clouds as shown in Chart I, therefore, indicate that although the horizontal velocity of the air below them is less than the average, the conditions are unfavorable for aerial experiments, especially near the clouds. During the night the vertical stability of the air is greatest.

Like the advent of the new born babe into the world, no great advance is ever made or new creation formed without intense suffering or even loss of life on the part of the human race. Silently and reverently let us bow our heads when we read the daily record of accident and death in aeronautics. The divine mind of man is at work in the greatest advance ever known to civilization. Painstaking care and investigation will eventually equip man with powers well-nigh those of the great Creator himself.

Aesthetic Side of Engineering Structure

A description of the new Coleman Plant of the Northern California Power Company appears as the leading article in this issue of the Journal.

It has been a rule in carrying out engineering work of this kind, especially at points distant from towns and cities, to leave the aesthetic side of the construction, the question of appearance and finish fitting for the location, as entirely secondary or altogether absent. Many engineers cannot see the importance of this point, for the simple reason that plants are designed with a prime object of accomplishing the development that is in view, with little thought of the many influences which may be brought to bear to invalidate successful operation, but which

may be overcome by the careful design of details. It may, for the moment, seem odd to think that the appearance of a power station would have any effect upon the future successful and efficient operation of that station. Such, however, is the case, as it affects the imagination and eventually the lives of those who must go through the daily grind which accompanies the operating of a plant of this kind. As it costs practically no more to give a pleasant and agreeable finish to building and surroundings, it pays well to consider appearances on the exterior as well as proper arrangement in the interior. The location of the Coleman plant is picturesque, situated as it is, in a shallow canyon, and surrounded not by heavy forests, but by more or less scrub oak timber and brush.

Much gray matter on the part of engineers is being wasted of late in considering all points leading to a correct valuation or factor to allow for depreciation. We have formerly commented in these columns concerning the factors certain evaluation experts allow for depreciation in certain classes of installation, and have drawn attention to the fact that these factors seem to vary in different plants, although the class of machinery may be identical. Undoubtedly the attitude of the management, the operating force, and of all even down to the humblest man on the job, has something to do with the wear and tear of a plant, and the consequent determination of the "factor of roughness" to be allowed in each individual case. Ganguillet & Kutter found in hydraulic measurements that the flow of water depends upon a certain coefficient of roughness in the bed or channel conveying the water. A canal made of well-planed timber or neat cement was found to have only 1/4 to 1/3 the coefficient of roughness in the case of canals or rivers in bad order.

And so it is in the case of the power house. Unconsciously, inspiring surroundings coupled with an exterior trim of the building itself designed in synchronism and harmony with nature will show its effect by producing cleaner, more earnest and caretaking attendants, and this will result in the material lessening of the co-efficient of managerial roughness to be applied in estimating the personal wear and tear on machinery and its consequent depreciation.

Municipal vs. State-Wide Control

A few issues back we called attention editorially to certain ugly features in California's new constitutional amendment No. 47.

The special session of the California legislature to be called for early in December will doubtlessly pass a new railroad commission act to carry out the provisions of Senate constitutional amendment 47, which authorized the legislature to confer upon the commission complete powers of regulation and control over all the public service corporations of the State, except such powers of control as the incorporated cities and towns now have and do not vote to confer upon the commission. The immediate result of this legislation will be that the incorporated cities and towns will keep the power of control which they at present have, being principally the power to fix rates and to exercise certain police powers, while the board of railroad commissioners will be vested with the entire residium of power to regulate and control such corporations.

Under these circumstances, the following reasons are urged in favor of having the incorporated cities and towns confer their powers upon the railroad commission.

1. The commission can do better work than the cities. Most cities do not have the money with which to secure expert engineers, rate men, and statisticians or accountants for the purpose of securing the information necessary to use as the basis for fixing rates. The State Commission will have a corps of trained experts who can do this work. The cities also often do not have the legal talent with which to enforce their orders in case they are attacked in court. The city of Berkeley recently confessed judgment in an injunction brought against it by the People's Water Company to restrain the enforcement of an ordinance reducing water rates, for the reason that the district attorney did not wish to go ahead without the assistance of high priced lawyers, and the mayor and councilmen were unwilling to supply the money to engage the additional lawyers.

2. Divided control will be confusing. The cities in the first instance will retain the power to fix rates. As to these same corporations, the State Commission will have the power to control issues of stocks and bonds, to regulate service and to exercise every other kind of control, except the fixing of rates and police regulations. If these same corporations extend beyond the city limits, the commission will have the power to fix rates for the service outside of the city, while the city fixes the rates for the service within. This division of responsibility will produce a certain amount of confusion, and it would be better to have unified control.

3. Control by the commission will produce more just results. In many cities, very little or no attention is paid by the city authorities to the fixing of rates, with the result that the corporations do about what they please, a result manifestly unjust to the cities. In other cases, men are elected to office on a pledge to establish a certain rate for one commodity, such as gas or electricity or water, without any investigation into the fairness of the proposed rate, a result clearly unjust to the corporations. The State Railroad Commission is not a party in interest, and its decisions are more likely to be just both to the cities and the corporation than the decisions of the city councils.

4. State control will result in uniform and consistent system of regulation. As contrasted with a system under which as many results may be established as there are cities exercising power over the different public service corporations, it is evident chaos and confusion must be the result.

5. The experience of other cities favors unified State control. This is the system which is working so well in New York, Wisconsin and Massachusetts. Within the last year or two, it has been adopted in Washington, New Jersey, New Hampshire, Ohio, Kansas, Nevada and Oregon. No other State provides for the divided authority which we have in California.

PERSONALS.

Mr. Cleavenger, representing the Phoenix Glass Company, is at San Francisco on a tour of the Pacific Coast.

F. B. Gleason, Pacific Coast manager for the Western Electric Company, is making a short eastern trip.

Thomas Bibber, representative at large of the Jovian order, and who travels for Edwards & Co., is at San Francisco.

Fred L. Webster, Pacific Coast manager for the Allis-Chalmers Company, is visiting the Seattle office of that corporation.

K. G. Dunn, with Hunt, Mirk & Co., has returned to San Francisco from a tour of Southern California on engineering business.

W. C. Kennedy, president of the Ontario Gas Company, of Ontario, Canada, is a recent arrival at San Francisco on a tour of the Coast.

S. K. Colby, manager of the electric railway department of Pierson, Roeding & Co., has returned to San Francisco after an extensive eastern trip.

Carl J. Young, an engineer in charge of the construction of a large irrigation dam in Nevada, is among the recent arrivals at San Francisco.

O. A. Hoff, formerly district engineer of the Pacific Telephone & Telegraph Company at Portland, has been transferred to the Seattle District.

A. F. Moulton, formerly district engineer of the Pacific Telephone & Telegraph Company at Seattle, has been transferred to the Spokane District.

Emory E. Smith, of the firm of Smith, Emery & Co., with offices in San Francisco and Los Angeles, has returned to San Francisco from the south.

Henry H. Thedinga has been appointed district sales agent of the Century Electric Company of St. Louis, Mo., with offices in the Central Building, Seattle, Wash.

C. H. Smith, who is connected with the executive department of the Westinghouse Electric and Manufacturing Company at East Pittsburg, is at Los Angeles.

Charles W. Waller, a former manager of the Great Western Power Company, has returned to San Francisco from London, where he went on important business.

A. H. Kling, representing the Detroit Fuse and Manufacturing Company, of Detroit, is at San Francisco, where the agency is carried by the Dodds-Caffray Company.

Fay Woodmansee, C. J. Davidson and E. O. Sessions have opened offices as consulting civil, electrical and mechanical engineers in the First National Bank Building, Chicago.

W. H. Wissing, formerly with the Union Light & Power Company of St. Louis, Mo., arrived at San Francisco this week to take the position of sales manager with the Sierra & San Francisco Power Co.

A. C. Balch and W. G. Kerckhoff, who are interested in the Pacific Light & Power Company and in the San Joaquin Electric Power Corporation, have been spending a few days at San Francisco on business.

Jesse Yount, the master mechanic, and John Finnegan, purchasing agent for the United Railroads of San Francisco, are again at their posts, after attending the National Street Railway Convention at Atlantic City.

O. H. Ensign, chief electrical engineer of the United States Reclamation Service, addressed the students of Throop Polytechnic Institute on October 23 on the work of the reclamation engineer. The Salt River project and others were described.

K. E. Van Kuran, assistant manager of the Westinghouse Electric and Manufacturing Company's Los Angeles office, is at San Francisco. He was formerly at the head of the switchboard division in the detail and supply department at the East Pittsburg works.

H. L. Walthers, formerly manager of the Yreka Railroad, is now manager of the Siskiyou Electric Power and Light Company and its subsidiaries. He has charge of the plants recently acquired from the Rogue River Power Company, with headquarters at Medford, Ore.

Thomas Pumfrey, formerly engineer of maintenance of way with the Portland, Light & Power Company, Portland, Ore., is now a member of a railway contracting firm engaged in railway construction for the Harriman interests. Mr. Pumfrey was presented with a gold medal by his former associates in the Portland Electric Company upon his resignation.

Sidney Sprout, electrical engineer, has returned to his San Francisco office after making a hyrdoelectric investigation on Smith River, where James H. Owen proposes to develop several thousand power for transmission to Crescent City and elsewhere. Three power sites are available, which, possibly, could be developed to the extent of 2,000 h. p. each.

Philip S. Dodd, secretary of the Commercial Section of the National Electric Light Association, is making a hurried trip throughout the Pacific Coast. He was entertained at San Francisco on October 30 and 31, leaving for Portland and Seattle on Tuesday night. He will return to San Francisco before going East and will address the electrical men at a luncheon on November 7, on "Cooperative Spirit."

A. C. Balch, of Los Angeles, vice-president of the San Joaquin Light & Power Corporation, has been at San Francisco during the past week. In speaking of the remarkable development of the San Joaquin Light & Power Corporation, Mr. Balch refers to the fact that the San Joaquin company now have on their system the largest artificial lake in California. This lake is formed by the immense rock-fill dam, the construction of which has been completed during the past summer by the engineering firm of J. G. White & Company, Incorporated. The dam, which impounds over 50,000 acre feet, has a maximum height of about 130 feet. Mr. Balch has just received the final reports of tests made on the new 20,000 h.p. power plant, which was also built by J. G. White & Company. Two of the units in this plant have been running for about a year, and two have been recently installed and put in service. Mr. Balch considers that this plant is a model of its kind, and that its design and the efficiency of the apparatus have combined to produce a power station of the very highest efficiency of which he has any record.

OBITUARY.

J. J. Ferrier, office engineer with the Southern Pacific electrical department, killed himself at his home in Fruitvale, California, on October 29. Mr. Ferrier was but 29 years of age and held an important position with the company which was based upon his previous experience with the New York Central Railroad. No reason is known for his suicide and his many friends are grief stricken. He leaves a wife and child.

Professor John James Montgomery, of Santa Clara College, who laid claim to being the real discoverer of modern aviation, and who was also noted as the inventor of an electrical rectifier now in commercial use, was killed October 31 by a fall from a monoplane glider, with which he was experimenting. The accident occurred at Evergreen, five miles from Santa Clara, California.

ELECTRICAL CONTRACTORS' NOTES.

Building is progressing nicely in Sacramento and Stockton and all the contractors are busy.

Paul Butte of the Butte Engineering & Electrical Company, has returned from a business trip to Oregon.

The wiring of the new Kahn garage on Sutter and Van Ness avenue, has been let for $2350 to a local contractor.

The members from San Jose Local No. 9 and Redwood Local No. 10 had a joint meeting October 23d. A pleasant meeting was held and trade conditions discussed until a late hour.

The John G. Sutton Company were awarded the wiring and steam heating contract for a seven-story building on the corner of Seventh and Market streets, belonging to Mrs. Jos. Dupuy, for $5750.

The wiring for the new theatre of the Downtown Realty Company, on Mason and Eddy streets, was awarded to A. E. Brooke-Ridley for $8450. The terms of the contract are that part of the payments are to be taken out in bonds. The bids ranged from $8450 to $13,000.

G. H. Duffield, special representative for the National Electrical Contractors' Association, left on the Lark Thursday night, after a very successful ten days in this part of the State gaining many new members for the National and assisting the State officers greatly.

Bids are being taken for the Odd Fellows' new home at Saratoga, near San Jose. The electric work will run close to $1500. A complete system of Electric lighting and telephones, also one of the most complete systems of fire alarms that has ever been installed is included.

NEW CATALOGS.

The Pacific Electric Heating Company has published the October issue of "Hot Points," which is gotten up in its usual attractive and interesting style, dealing largely in subjects akin to electrical heating.

Descriptive leaflet 2378, covering Rotary Converters for Railway Service, has just been issued by the Westinghouse Electric & Manufacturing Company. Under each picture is given a short description of the method of construction of the part illustrated.

Holabird-Reynolds Co. has just issued catalogue No. 2 on electrical supplies. The catalogue contains 310 pages and the handsome and attractive manner in which the book is gotten up is a credit not only to the company interested, but is a compliment to the progress of the electrical trade on the coast.

The Westinghouse Electric & Manufacturing Company has issued circular 1131, describing Graphic Meters for Switchboard Service. The publication shows illustrations of the meters together with typical charts taken from same, indicating the various uses to which graphic meters may be put with advantage to the user.

The Okonite Company, 253 Broadway, New York City, has published an attractive booklet entitled "Economy in Joint Making, With Instructions." It contains information which should be very much in demand just at this season of the year, as now is the time to make repairs in the way of insulating and protecting joints so that short circuits, with their accompanying troubles, may be avoided during the winter to come. Copies of the booklet can be secured on application to The Okonite Company.

In its folder No. 4186, dated September, 1911, the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., describes an auxiliary line switch for use on trolley cars equipped with ordinary drum type controllers. Westinghouse Railway Equipment is the title given by the company to its folder No. 4184, dated September, 1911. This is an art folder, time table size, and it has a very attractive cover. Descriptive leaflet No. 2371, dated August, 1911, treats of the Type O engine driven, direct current interpole generators, manufactured by that company. The leaflet is letter size (9 in.x11 in.), and is arranged to bind in with correspondence.

MEETING NOTICE.

The broad-gauged men in the electrical industry are coming to realize more and more not only the value of co-operation in the electrical industry but the vital necessity for it. This fact was strongly brought out at the last annual meeting of the Sons of Jove, held at Denver, Colorado, 16-18th of October, and a number of suggestions made for practical co-operative work that could be carried out by the Jovian order.

Probably one of the most valuable movements which has been inaugurated in the electrical industry since its inception was the organization of the commercial section of the National Electric Light Association which, through the work of its various committees during the past year, has gone a long way toward proving the value of co-operative work.

Philip S. Dodd.

Philip S. Dodd, the secretary of the Commercial Section of the National Electric Light Association, will be in San Francisco during the coming week and there is a movement on foot to hold a luncheon on Tuesday, the 7th of November, which will be attended by electrical men from every branch of the industry. Mr. Dodd has been invited to tell us at that time of what co-operation has done and what its possibilities may be.

BASEBALL GAME

The baseball game at Golden Gate Park playgrounds last Saturday between the teams of the Pacific Gas & Electric Company and the General Electric Company was a great success. The score for the seven innings played, was 13 to 12 in favor of the General Electrics. There was a large turn out of representatives of both corporations, who rooted for their respective players. T. E. Bibbins gave satisfaction as umpire. The lineup was as follows: General Electrics—Shreve first base, with Fulton as alternate; Alvord second base; Hunt, third base; Jollyman, catcher; Jones and Gracia, pitchers; Laingor, shortstop; Boyd, right field; Patterson, center field; Wheeler, left field. Wheeler distinguished himself by going to the bat five times, making three hits, three runs and two stolen bases.

Pacific Gas & Electric—Rogers, first base; Lisberger, second base; Varney, third base; Cain and Lusk, pitchers; Mensing, catcher; Bostwick, shortstop; Bridges, right field; Henley, center field; Keppelman, left field. Mensing was at the bat twice and made two three-baggers. The best hitting was done by Frank H. Varney, who made four hits. A return game will be played.

INDUSTRIAL

ELECTRIC OIL HEATER.

The use of electric immersion heaters in the transformer and switch oil supply tanks of the Nisqually power development of the City of Tacoma, Wash., is perhaps one of the most novel of the recent industrial applications of electric heating. Mr. H. F. Gronen, chief engineer of the Nisqually project, has authorized the Seattle office of the Westinghouse Electric and Manufacturing Company to furnish their bayonet type of heaters for the tanks at the La Grande plant and at the Tacoma substation.

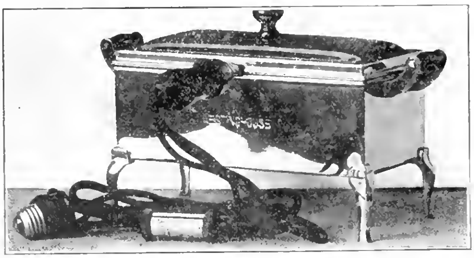
New Type Electric Oil Heater.

For the transformer oil tanks the order calls for three 24 in. bayonet heaters, each having a maximum heat input of 3 kw. and provided with a series-parallel switch giving six different heat combinations. The oil switch tanks will be equipped with three 12 in. 1½ kw. heaters with similar switches. The wiring is arranged so that the load on the three-phase bank of transformers will be balanced on the different phase, one heater being connected across each phase for each bank.

The heating element consists of slotted resistance ribbon incased in a mica insulated sheath and the whole inserted in flattened copper tubes. These tubes are sealed at their ends and are brazed into a capped casing. On these pipe plug castings are mounted the terminals for making the outside connections. As the whole unit consists of nothing but metal and mica, there is very little danger of mechanical damage or breakage of parts due to sudden changes in temperature. This construction is such that any length heater up to the limit of mechanical strength may be supplied on almost any voltage up to 250 volts.

THE WESTINGHOUSE INSTRUMENT STERILIZER.

The psychological effect of sterilizing instruments in the presence of the patient is rapidly becoming recognized by



New Electric Instrument Sterilizer.

physicians, dentists and hospital attendants, therefore the advantage of having at hand a convenient and ready method of sterilizing is apparent to all.

Instruments may be perfectly clean and disinfected but the mere fact that the operation of cleaning them is done before the eyes of the patient goes a great ways towards putting them in a more satisfied frame of mind.

The sterilizer described below enables this to be done in a very convenient and inexpensive manner.

The device consists essentially of the vessel for the instruments and the separable heater element with its attachment plug, cord, and switch.

The dimensions of the sterilizer permit the use of instrument trays which are similar to the standard design and can be lifted out by means of the handle of the heating element which is always cool. This construction obviates the inconvenience of using forceps or other instruments for removing the trays, a feature of particular advantage to a person using a sterilizer while engaged in other duties.

Sterilizer in Sections.

The heater element is of the well-known Westinghouse immersion type, and is placed within the instrument vessel containing the water. It is supported a short distance from the bottom by flanges on the sides of the perforated metal tray, thus allowing free circulation of water above and below.

The heater is equipped with a substantial wood handle having an ebony finish which serves as a means of lifting out the instrument tray. The handle is always cool and its finish adds to the attractive appearance of the sterilizer.

The cost of operation, is practically negligible as it is only necessary to run it on the high heat for a very short time and then switch to the low heat.

The sterilizer is manufactured by the Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

NEW ELECTRIC HOT PLATE.

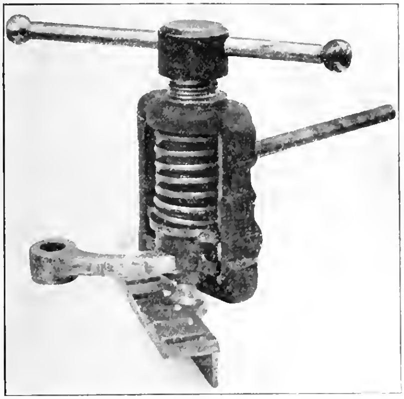
The new 8-inch disk stove now being placed on the market by the General Electric Company is designed for use in readily increasing the capacity of the kitchen equipment of hotels and restaurants, and also for use in carpenter shops, binderies and other manufacturing establishments requiring a high power rapid heating hot plate free from the inherent dangers of gas plates.

A New General Electric 8-Inch Disk Stove.

The stove is provided with a heating element of Calorite, and a three-heat indicating switch serves to give 375, 750, and 1500 watts heat dissipation on 95-128 volts, or 300, 600, and 1200 watts on 200-250 volts.

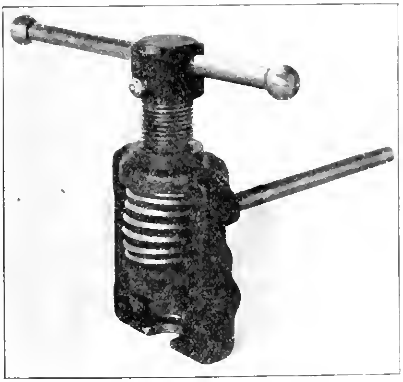
CONNECTOR PULLER FOR DISCONNECTING CELLS OF "EXIDE" VEHICLE BATTERIES.

The individual cells in the various types of "Exide" Batteries are joined together by connectors integrally burned to the strap post. This burned connection is the most positive and satisfactory. When one or more cells have to be cut out, it has heretofore been customary to do this in one of two ways: either loosening the connector by putting a flame on the burn, over the post, or boring through the burn with a brace and bit.



New Electric Connector Puller

The Electric Storage Battery Company has now perfected a connector puller, a device which mechanically uncouples the connectors by shearing, leaving both post and connector in perfect condition for reburning. In order to accomplish this, it is necessary that the plunger which does the shearing be very accurately aligned and centered. This connector puller has been so designed that the centering is done in a very positive manner, and the connector must come off true.



Connector Puller in Place

The connector puller fits the pillar strap of all types of "Exide" cells, including the "Ironclad-Exide," and is manufactured in two sizes. One size, No. 8879, fits all cells corresponding to the 13 plate "Exide" (5 inch jar) and smaller; while the other No. 8880, fits those corresponding to the 15 plate "Exide" (5¾ inch jar) and larger.

The two illustrations, showing the puller alone and in place ready to work, make clear the method of operation.

WESTINGHOUSE EXHIBIT AT ATLANTIC CITY.

Among the interesting exhibits made by the Westinghouse Electric & Manufacturing Co. held at the Atlantic City Convention of the American Electric Railway Association was a complete equipment of the 1500 volt, direct-current control system. The exhibit also included a No. 321, 75 to 90 horsepower motor for operation on 1500 volt direct-current. Also a 1500 volt dynamotor and compressor was in operation. In the design of the latter machine a radical departure from standard practice was made. This compressor will prove particularly effective on 1200 and 1500 volt systems for the reason that it reduces the voltage for the control and lights, and at the same time operates the air compressor when it is actuated by the governor. Therefore, it also eliminates the use of a special motor compressor for 1200 or 1500 volt equipment.

The well-known Westinghouse Type HL Unit Switch Control was also exhibited in actual service, connected to two motors rigged up with a pony brake.

Exhibits were also shown of single-phase railway motors and interpole direct-current railway motors together with a complete line of detail apparatus, such as controllers, circuit-breakers, commutators, resistors, and trolley line material.

The company was well represented by a considerable number of the officials and salesmen, among whom were President E. M. Herr, Vice-President L. A. Osborne and C. A. Terry, H. P. Davis, Sales Manager S. L. Nicholson, Manager of Railway and Lighting Department C. S. Cook, Manager of Detail and Supply Department G. Brewster Griffin, Manager of Department of Publicity J. C. McQuiston; F. N. Kollock, manager Seattle office; S. J. Keese, manager of Los Angeles office, and T. J. McGill, manager of Atlanta office.

ELECTRIC EQUIPMENTS IN A NEWSPAPER PLANT.

The New York Globe has recently installed an interesting electric equipment in its new plant at Washington and Dey Streets, New York, which is one of the most complete and modern installations of its kind. On the first floor are three high speed sextuple presses capable of turning out 36,000 24-page papers per hour, and two standard speed sextuples, which turn out 24,000 papers of the same size. These presses are all driven by Sprague Electric Motors and operated by the Kohler full automatic system of printing press control. The motors for the high speed presses are 60-horsepower and have an operating range between 18,000 and 36,000 papers per hour entirely by field control, that is, without any unnecessary loss or waste of current. For threading in the web the cylinders are turned over at ten revolutions per minute by a 10-horsepower motor, which is connected to the drive shaft of the large motor through double reduction spur gearing. The two standard speed presses are driven by a combination of 50 and 10-horsepower motors.

TRADE NOTES.

Frank H. Ray, who recently sold his electric power interests on Rogue River to the Siskiyou Electric Power and Light Company, is at San Francisco from the new prospect hydraulic plant

The General Electric Company has sold to F. C. Roberts & Co., contractors for installation in the new San Francisco City and County Hospital, four C. C. 4, 125 kw., 2400 r.p.m., 125 v., 250 v., three-wire, non-condensing Curtis turbine generating sets. Also a switchboard of eleven panels.

The American Electrical Works has closed a contract with the San Francisco Department of Electricity for weather proof and bare copper wires covering the municipal requirements during the ensuing year. This sale was negotiated through the Pacific Coast agents, the Telephone-Electric Equipment Company.

NEWS NOTES

INCORPORATIONS.

ABERDEEN, WASH.—The Mutual Heat & Light Company of Aberdeen has been incorporated for $50,000, by W. Mack and M. Snyned.

LOS ANGELES, CAL.—The West Coast Gas Light & Fuel Company has been incorporated for $75,000, by W. J. and J. McGimpsey.

DELANO, CAL.—The Delano-Linns Valley Telephone Company has been incorporated for $10,000, by Ben Thòmas, J. C. Rutledge, A. Villard, P. Girard and R. W. Lockridge.

FINANCIAL.

LOS ANGELES, CAL.—Judge Wellborn has found for the defendant in the action brought by the Los Angeles Gas & Electric Company against the Western Gas Construction Company of Fort Wayne, Ind., to recover $28,323.45 alleged to be due on a breach of contract in the sale of water-gas apparatus. He found for the plaintiff on the cross-complaint of the defendant asking judgment for $18,210.95. Under this ruling the Los Angeles corporation must pay the balance of $6,667.55, due on the original price of $35,000 for the apparatus. Each side must pay its own costs.

SAN FRANCISCO, CAL. The stockholders of the Pacific Gas & Electric Company at meetings held at the company's offices in this city, authorized the creation of a new mortgage upon the company's properties, under which it may, from time to time, as required, issue its bonds to the maximum amount of $150,000,000. This new bond issue will provide the means for refunding or retiring at maturity, or as occasion may arise, all of the existing bond issue of the Pacific Gas & Electric Company and of subsidiary and controlled corporations. At this meeting the stockholders also approved an increase in the common stock of the company to $150,000,000, this being also the amount of the new mortgage which was authorized. The company does not contemplate the immediate issuance of any of this stock, the action of the stockholders in authorizing the increase having simply been taken to enable the company to comply with the California statute under which no California corporation may have outstanding indebtedness in excess of its subscribed capital stock.

BLUE LAKE, CAL.—There has been a serious break in the negotiations by the Western States Gas & Electric Company of Eureka for the purchase of the local electric light system, owned and operated by the Minor Mill & Lumber Company of Glendale and for the time being, at least, the deal is off. Report has it that Manager H. L. Jackman of the Western States Gas & Electric Company has agreed upon a purchase price for the system with I. Minor but that when it came to signing the papers Minor raised the price by several thousand dollars and was abruptly turned down. Mr. Jackman was at Glendale several days ago arranging the deal with Mr. Minor and at that time Minor stated that the transfer would probably take place within the next few days. He now refuses to say anything, except that the negotiations are at an end, at least for the present. It is said that the Western States Company made its final bid, which was somewhat less than the price finally asked by Minor and that there will be no transfer unless the latter comes to terms. The Blue Lake lighting system, with a power plant at the Glendale mill of the Minors, is the only independent system in the county at present, the Western States Company having within the past year acquired the systems at Arcata, Fortuna and Ferndale.

TRANSMISSION.

FOREST, CAL.—The North Fork mine is making surveys and estimates of cost for the installation of an electric light and power system.

SAN JOSE, CAL.—The Great Western Power Company has applied for a franchise for a transmission line along the county roads of Santa Clara county.

SACRAMENTO, CAL.—The Great Western Power Company has been granted permission to lay an underground wire system on certain streets of this city.

DORRIS, CAL.—The Siskiyou Electric Power & Light Company has a large force of men engaged on the preliminary work for the extension of its lines to this town.

SACRAMENTO, CAL.—The Pacific Gas & Electric Company has made application for a lighting and power franchise in the recently annexed sections of Sacramento.

CASTLE ROCK, WASH.—The City Council has granted to H. B. Davis and the Tacoma Investment Company, a franchise to operate and maintain an electric power system in this city.

SEATTLE, WASH. The power house of Schwager & Nettleton mills, including contents, was entirely consumed by flames, entailing a loss of $25,000. The plant will be replaced at once.

Portland, ORE.—General Manager O'Brien states that work of electrifying the west side of the Southern Pacific railway will start as soon as orders to that effect have been received from headquarters.

STOCKTON, CAL.—The city is planning for the installation of a municipal underground conduit system in the business district, to be rented to the private companies. An election for this issue will be held November 7.

SEATTLE, WASH.—The plans and specifications prepared by the B. P. W. providing for constructing the first section of a municipal street railway were approved by the city council and bids have been ordered advertised for.

BERKELEY, CAL.—The Sierra and San Francisco Power Company is planning for the installation of a power and lighting system at Berkeley. No franchise is required for this work and the City Council has been notified of the intentions.

SALEM ORE.—It is rumored that an electric line will be constructed between this city and Stayton. It is further reported that an official of the Portland, Eugene & Eastern road is negotiating with the Eugene council regarding franchises, etc.

TULARE, CAL.—The Tulare County Power Company has awarded a contract to Hunt, Mirk & Co., San Francisco, for the installation of a 3000 h.p. steam-turbine generating plant at Tulare. Construction work on a distributing system will soon commence.

BEAUMONT, CAL. C. H. L. Ghriest, owner of the Newport Beach Electric Light & Power Plant, has been here looking over the town with a view of establishing a plant here. He will furnish light and power and establish in connection a steam laundry and ice plant.

STOCKTON, CAL.—The Sierra and San Francisco Power Company plans for the installation of a distributing system at Stockton, with underground conduits in the business section. An auxiliary steam generating plant will be erected to serve the city. The company has commenced construction on a transmission line from Manteca to Stockton.

EVERETT, WASH.—It is reported that the Stone & Webster interests are preparing the installation of a power plant in Sultan Canyon. Fourteen hundred acres of land have been secured from the government and a 200-foot dam is to be constructed above the narrow gorge.

SACRAMENTO, CAL.—President T. T. O'Gregory of the Sacramento-Woodland Railroad, has awarded a contract to the Dozier Construction Company for the construction work of the line between Woodland and Elkhorn, and to Cooper and Hawley for the construction of another section.

HELENA, MONT.—The United Missouri River Power Company, which owns Canyon Ferry, Hauser Lake and the uncompleted Holter hydraulic plants on the Missouri River, has gone into the hands of a receiver on request of the United States Mortgage and Trust Company of New York, which holds a bond of $12,500,000 of the company's.

McMINNVILLE, WASH.—The County Court has granted to the Yamhill Electric Company the right to set up poles and string wires along the Dayton-Portland road from the corporate limits of Newberg easterly to the county line, and along all other public roads leading from and into Newberg for a distance of three-fourths of a mile outside of said limits.

PORTERVILLE, CAL.—C. H. Holly, chief engneer of the Tulare County Power Company, is quoted as saying that the company will be delivering power to the patrons of the line not later than April 1, 1912. The substation for the orange district will be located at Strathmore, and a site has been secured in Tulare for a station which will supply the dairy district and where a steam auxiliary will be located.

PORTLAND, ORE.—Philadelphia capitalists, it is announced, will shortly start construction of an electric railway between Canby, Ore., and Portland with a system of feeders to affect the country tributary. The enterprise includes the drilling of a tunnel under the hills back of Portland, and a subway to have a teminus in the heart of the city. According to estimates submitted by engineers the project will aggregate a cost of $5,000,000.

BAKERSFIELD, CAL.—By November 1 the Weed Patch district lying southeast of Bakersfield, will be supplied with electric power by the San Joaquin Light & Power corporation. Right of way is now being secured and parties who have contracted for power have been assured it will be available within a very few weeks. Power will be brought from the main line at Edison via a main Weed Patch line about 14 miles. Power is to be supplied at the rate of $50 per h.p. per year. Among those who have already contracted for power is H. F. Seat who has 800 acres in the heart of the Weed Patch and who has ordered a 20 h.p. motor to supply the tract with water. The Foothills Citrus Colony with 180 acres has contracted for 480 acres and Mr. Moore will also operate his pumping plant with electric power. Mr. Seat states that land values in the Weed Patch now worth $50 per acre without water and $100 per acre with water, will, in a year or two, advance to $75 for barren land and $150 per acre for land well supplied with water.

SAN FRANCISCO, CAL.—According to President James W. Goodwin of the Oro Electric Corporation, his company has made preliminary plans to build a power plant on the Feather River about 40 miles north of Oroville and to extend its power lines through Oroville and Marysville into Sacramento and eventually into Oakland and the bay cities. The Oro Water, Light & Power Company, a subsidiary concern, now furnishes electric light and power to the city of Oroville, maintaining a power plant on the river near that city. The parent corporation owns a valuable power site further up the river, and it is in the development of this site and the erection of a plant there that the first money derived from the sale of the bonds will be expended. The Oro Electric Corporation was organized last March with a capital of $10,000,000, of which $7,500,000 is said to have been subscribed. A few weeks ago official notice of the authorization of a bonded indebtedness of $10,000,000 was filed. The bonds to be issued will carry 6 per cent interest and will run for 40 years. James W. Goodwin, president of the company, holds 74,940 shares of the stock. The other directors are James K. Moffitt, J. D. Galloway, F. A. Benicke, W. S. Wilsey, F. S. McAllister and W. G. Jack.

TRANSPORTATION.

PORTLAND, ORE.—The Oregon Electric Railway is double tracking its line through this city.

COTTAGE GROVE, ORE.—It is reported that the Oregon Electric Railway will consider the proposition of constructing an electric railway system here.

NANAIMO, B. C.—A communication was received by the British Columbia Hydraulic Company of Victoria regarding the installation of a tramway system.

PORTLAND, ORE.—Franchise has been granted Hartman & Thompson, Chamber of Commerce Building, to construct a street car line on Sandy road, from the city limits to Parkrose.

LOS ANGELES, CAL.—The Pacific Electric Company is planning to have the Inglewood avenue and Hawthorne lines to Redondo Beach standardized; also the narrow gauge line to San Pedro.

EUGENE, ORE.—McDougall & Guthrie, who have the contract for grading the Oregon Electric railway right-of-way between Albany and Salem, are reported as also having secured a similar contract on grading the company's line between Eugene and Albany.

FRESNO, CAL.—The bonds of the Fresno, Hanford & Summit Lake Interurban Railroad Company have at last been taken over by the Philadelphia underwriters, according to a telegram received in Fresno from the attorneys of the railroad company in New York.

MONTEREY, CAL.—An order for the rails necessary for the completion of the Monterey and Seaside street railway has been placed and the intention of the owners, the Phelps Company, is to at once commence operations for the finishing of the road and placing it in operation.

HEALDSBURG, CAL.—It is reported on good authority that during the coming year the line of the Petaluma and Santa Rosa Electric Railway will be extended to Healdsburg. A bond issue has been negotiated with well-known Eastern capitalists to finance the building and equipment of the road.

SEATTLE, WASH.—The Highland Park and Lake Buren Railway Company has been incorporated and proposes to build an electric railway from First avenue south at Ox Bow to Lake Buren. Later the incorporators will push the line on to Tacoma. The trustees of the corporation are W. H. Murphy, F. W. Dashley, Dr. D. Burkhart, Geo. White, Chas. Schoening and others.

OAKLAND, CAL.—Plans calling for a two-story modern concrete and steel power storage plant to be erected at the Melrose terminal of the Seventh street local at the cost of $30,000 have been accepted by the local officials of the Southern Pacific Company and work will be started at once in an effort to have the plant ready by the forepart of November, when the local system will be turned into an electric line.

OAKLAND, CAL.—An application for a street railway franchise beginning at the intersection of the north boundary line of the city of Berkeley with the center line of the Arlington road to its intersection with the northern boundary

line of the county of Alameda, was made Monday by the Oakland Traction Company at a meeting of the Board of Supervisors. A 50-year franchise is asked for, which is practically an extension of the Euclid avenue line. The application was referred to the franchise committee.

FRESNO, CAL.—Assurances have been received by the Fresno, Hanford & Summit Lake Railroad Company that within the next day or so the first shipment of rails for the interurban line from Fresno to Kingsburg and Sanger, will be made. It is expected that the laying of rails will start November 15. H. A. Hansen, who has just secured the contract for the concrete and pile bridge work of the road will begin work this week. Everything is in readiness and it is not expected that there will be any delay.

SACRAMENTO, CAL.—Franchises have been granted to the Pacific Gas & Electric Company by the City Trustees to extend the street car lines through the city in four new sections, the company being the only bidder for the privilege. It is to pay 2 per cent of the gross receipts annually after the first five years. The four sections were: On T street from Twenty-eighth to Thirty-first; on Third from J to I and west to Second; on E from Thirty-first to Seventh, and thence to G; on K from Fifteenth to Twenty-first, and thence to P.

VANCOUVER, WASH.—Lawrence Harmon, who was recently granted a franchise for the construction and operation of railway lines over certain streets in this city, in a statement announced that the sum of $3,000,000 would be expended in Vancouver, Clarke and adjoining counties on development work. Suburban railway lines and feeders will be built, water power developed and townsites will be established. The franchise provides that work on the local electric railway system start before April 1st and 1½ miles of track is to be in operation by April, 1913.

EMERYVILLE, CAL.—Active work has been started on the erection of the $200,000 plant of the Westinghouse Pacific Coast Air Brake Company, affiliated with the Westinghouse Air Brake Company of America, at Park avenue and Halleck street. The officers of the new Westinghouse Pacific Coast Air Brake Company are: H. H. Westinghouse of New York City, president; S. G. Gown of San Francisco, vice-president; H. S. Clark of Berkeley, second vice-president; A. L. Humphrey of Pittsburg, general manager; S. N. McMunn of Oakland, secretary and auditor, and F. C. Mortimer of Berkeley, treasurer.

ILLUMINATION.

SEATTLE, WASH.—Municipal light extension bonds in the sum of $1,000,000 were authorized to be advertised for sale.

FLORENCE, ORE.—The proposition of granting a franchise to the Oregon Electric Company here was voted down at a recent election.

LA MESA, CAL.—The San Diego Consolidated Gas & Electric Company will soon commence the laying of its gas mains from City Heights to La Mesa.

VICTORIA, B. C.—Bids will be received by the purchasing agent up to November 3rd for furnishing 2,600 12-inch R. I. globes and 100 14-inch globes for the lighting system.

SNOHOMISH, WASH.—The City Council has authorized the Mayor and City Clerk to enter into a lighting contract with the Everett Gas Company for a period of ten years.

CASTLE ROCK, WASH.—H. B. Davis, J. W. Selden and the Tacoma Investment Company have received a fifty-year franchise and a five-year contract to furnish this municipality with lights.

AUBURN, WASH.—The country around Auburn will have the advantage of gas for heating and lighting if the franchise applied for by the Seattle Lighting Company of Seattle, is granted.

MARYSVILLE, CAL.—The Butte Construction Company of San Francisco has been awarded the contract for seven arches to be used in lighting the business section of Marysville. The bid was for $6100.

OAKLAND, CAL.—Alfred Olson and fourteen other residents and property owners in Castro Valley, have petitioned the board to install street lights in the valley on the Dublin road and on the Redwood road.

LYLE, WASH.—As the result of a ruling of the Superior Court, the Northwest Electric Company is given a right to condemn property for right-of-way purposes. Work will be resumed at once on the $1,000,000 water power project on the Klickitat.

SAN DIEGO, CAL.—Normal Heights, a suburb of San Diego, and City Heights, an adjoining suburb, have voted to install street lights. Normal Heights will install sixteen arc lights on Adams avenue and City Heights will install sixty arc lights.

SUMAS, WASH.—At the council meeting the bid of the Cascade Trading & Construction Company, in the sum of $772.50, for the erection of electric light poles, was accepted. The bid of the Western Electric Company in the sum of $2717.54 for the construction of electric wire for construction of a light system was also accepted.

MONTESANO, WASH.—T. H. Minear of Tacoma is superintending the installation of foundations for the new power house to be erected at the plant of the Montesano Light and Power Company, north of the city. The structure will be two stories in height, 30x40 feet, of concrete construction, and will be completed within 60 days. The Pelton-Francis turbine pattern engine, to develop 315 h. p., will be installed, and two Westinghouse pattern 100-kilowat capacity are specified.

TELEPHONE AND TELEGRAPH.

ALBANY, ORE.—The Pacific States Telephone & Telegraph Company have asked the city of Harrisburg for a franchise.

CHEHALIS, WASH.—Application has been made by J. Y. Coffman for a franchise to operate a telephone system in the city of Chehalis for fifteen years.

HAMILTON, MONT.—The Flathead Independent Telephone Company, capital $50,000, has been incorporated by A. H. Stephens, V. H. Calhoun and F. C. Wilhelm.

TEKOA, WASH.—Mr. Gray representing the Pacific States Telephone & Telegraph Company, has asked for a franchise to erect and maintain a telephone system for a term of 25 years.

ASTORIA, ORE.—The Court has granted a franchise to the Centennial Telephone Company to operate their telephone line over the county roads and set the necessary poles between Elsie and Jewell.

EUREKA, CAL.—Through the co-operation of the United States Forest Service, the Hoopa Indian Agency and the California Mining & Dredging Syndicate at Orleans, and Upper Klamath River and Hoopa section will soon be connected by telephone with the outside world.

PASCO, WASH.—An ordinance calling for the purchase of the city waterworks system of the Pacific Power & Light Company at the figure of $46,000 and which was vetoed by Mayor Captain Gray, two weeks ago, has been passed by the City Council over the mayor's veto.

CHELAN, WASH.—At a meeting of the Eastside Telephone Company arrangements were made for rebuilding the company's telephone line the coming fall.

FLORENCE, ORE.—At a recent election the proposition of granting a franchise to the Florence-Mapleton Independent Telephone Company to erect and maintain poles and wiring was voted down.

STANFIELD, ORE.—The City Council of Stanfield has passed an ordinance granting to C. P. Bowman a franchise for the construction of a telephone exchange and long distance lines for a period of 25 years.

EUGENE, ORE.—The Pacific Telephone and Telegraph Company will soon commence construction of a new line between Eugene and Cottage Grove. The company will also extend and improve its systems at Roseburg and Albany. About $75,000 will be expended in this work.

SALMON, IDA.—It is reported that the Lemhi Telephone Company, in which President W. A. McCutcheon is largely interested, will extend its line sixty miles down the river. This is taken as an indication that the Gilmour & Pittsburg will start railway construction work next spring.

WALLA WALLA, WASH.—C. P. Van Houtte, district commercial superintendent of the Pacific Telephone & Telegraph Company, announces that toll line improvements in this district will entail an expenditure of $80,000. The work will be under the direct supervision of C. H. Pfleeger, and consists of the following: $1,000 for a new additional toll line between this city and Touchet; $17,220 for an additional line between Walla Walla and Colfax; $14,000 for a new line between Prosser and Wallula; $15,000 on new lines between North Yakima and Prosser; $30,000 for additional toll lines between Arlington and the state line points, and several hundred dollars each for installing a private exchange carrying 117 phones in the new Hotel Grand, the placing of two modern switchboard sections at Waitsburg, and minor improvements to be made in the local service.

WATERWORKS.

MARICOPA, CAL.—Frank Torpey, of the firm of Torpey & Jones, has appeared before the board with a request for a franchise for the putting in of a $100,000 water system.

REDMOND, ORE.—The Council has recommended that immediate action be taken for the installing of a water system for the city, to be owned, operated and controlled by the city.

EXETER, CAL.—The entire plan of the new water system was gone over carefully with the engineer, Mr. Sloan, a few changes made of minor importance and the plans accepted.

YERINGTON, NEV.—The City Council has accepted the bid of the American Light & Water Company of Chicago, which company bid to construct the water system for $31,940, and take the bond issue at par.

PORTLAND, ORE.—The city water board has ordered the construction of a large feeder water main from Division street south to the heart of the Sellwood district. The estimated cost of the main is $129,000.

TWISP, WASH.—At the regular meeting of the council the question of installing a water system for the town took a turn in its favor. The city attorney was instructed to draw up an ordinance for bonding the town to raise $12,000.

PRUSSER, WASH.—Upon motion of T. E. Brockhausen the city attorney has been instructed to prepare an ordinance calling for a special election to decide whether or not the city will vote bonds to construct a domestic water system to cost $48,000.

VICTORIA, B. C.—Bids will be received by the city clerk of Prince Rupert, B. C., on or before November 20th for the supply of approximately one thousand, eight hundrd tons of cast iron water pipe; 38 tons of special castings, and a quantity of gate valves, valve boxes and hydrants.

RENO, NEV.—The new power company has completed its surveys for power sites and ditches from the Truckee River east of Reno. The work of building the power plants will soon commence. This company has two power sites and intends to install plants that will generate electricity up to 9000 h.p.

POCATELLO, IDAHO.—A special bond election will be held in the Gate City to afford qualified electors who are taxpayers an opportunity to vote on the question as to whether or not there shall be issued $270,000 worth of 20-year bonds, to acquire by purchase, construction or otherwise, a municipal water system.

KLAMATH FALLS, ORE.—Ex-postmaster R. A. Emmitt, who was engaged by the city at an expense of $281.30 to investigate water sources for purer water system for Klamath Falls, examined a number of proposed sources, of which he concludes the best is Sun Creek, altitude 200 to 600 ft. with 5,000,000 gallon flow of water per day. About 3 miles of pipe would be necessary.

RICHMOND, CAL.—The case of the Peoples Water Company vs. the City of Richmond will be erased from the court calendar by a compromise, according to a statement of City Attorney B. H. Griffins, at the last meeting of the City Council. The old rate of 35c per 1000 gallons will remain in force and the water company agrees to refund to the city $550 as excessive charges on fire hyrdants.

BAKERSFIELD, CAL.—The Western Water Company promises to have its plant and pipe line in readiness for delivering water to its customers in the vicinity of Taft about November 15. The company already has its pumping plant installed on the flat near Button Willow, and excellent progress is being made in laying the pipe line. The water is to be piped to two hills, and distributed thence by gravity to the companies operating on Twenty-five hill and elsewhere in the Midway field. Service will be extended to North Midway about 15 or 20 days later. The deliveries about Taft will amount to approximately 15,000 barrels daily, but the system will have a capacity of 50,000 barrels daily. The water will come from artesian wells and will be forced through the pipe line by the power from two 250 h.p. engines. Only one engine is to be used at a time, however, the other being for emergency use to obviate the necessity of shutting down for repairs, a difficulty that has interfered with the service of some of the other water companies, that have furnished water to the West Side fields.

BERKELEY, CAL.—Water rates to be effective in this city for the ensuing year were fixed following a secret session between a representative of the People's Water Company and the City Council, at an executive meeting held in the office of Mayor J. Stitt Wilson, following which a public meeting was held and the arrangement made read in open meeting. As the result of this new schedule of prices made effective, residents of this city will pay the highest rate which has been in effect here for a number of years. The case has been before the U. S. Circuit Court, and, after a preliminary skirmish, steps were taken to effect a compromise. The agreement reached establishes a rate effective until July 1, 1912, of 35c per 1000 gallons with a minimum of $1.50 per month for householders' use; of 35c for municipal use; of $4 per month for each fire hydrant of four inches diamater or over; of $1 per month for small hydrants and of 30c for street sprinkling. The rates on which the suit was brought provided for a rate of 35c per 1000 gallons, minimum or $1.25; 35c for municipal uses; $3 for large and 50c for small hydrants, and of 30c for street sprinkling purposes.

ALPHABETICAL INDEX TO ADVERTISERS

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ELECTRICAL ACTIVITIES IN SPOKANE

Spokane has the third greatest system of interurban electric railways in America, being exceeded only by Indianapolis and Los Angeles. The city also has more miles of street car lines than any other city of similar population in the United States and Canada. The Washington Water Power Company and the Spokane Traction Company occupy 92.71 miles of streets and operate 154.11 miles of tracks, or nine-tenths of a mile of street occupied by tracks for every 1000 population. The total investment by the two companies is $42,000,000.

Spokane Terminal of Spokane & Inland Empire Railroad

Electric railway building in Spokane began in 1902. A. Bettis of Detroit, Mich., was the original promoter of the interurban electric road. He interested in his project F. A. Blackwell of Coeur d'Alene, Idaho, who, as the representative of the Howard Lumber Company of Pennsylvania, was attracted to the western country by the great timber reserves around Coeur d'Alene lake. Mr. Blackwell and his associates furnished the money, and, despite prophesies of financial disaster, the first interurban road from Spokane to Coeur d'Alene, 34 miles, was built. The road was opened

to traffic in the winter of 1903 and proved a dividend payer from the start.

Shortly before the completion of the Coeur d'Alene & Spokane Electric Road, Jay P. Graves, vice-president and general manager of the Granby Consolidated Mines & Smelting Company, entered into competition with the Washington Water Power Company for the street railway traffic of Spokane. Afterward he joined forces with Mr. Blackwell and the result was the organization of the Spokane & Inland Empire Railway Company with a capital stock of $30,000,000 and the construction of an interurban electric line, from Spokane south to Rosalia and Palouse, Wash. Later the Palouse branch was extended to Moscow, Idaho, and the Rosalia branch was carried to Colfax, Wash.

The Coeur d'Alene & Spokane Railway was absorbed by the Spokane & Inland Empire Electric Railway Company and the line was extended from Coeur d'Alene to Hayden lake, Idaho, 42 miles, and a spur of 17 miles built to Liberty lake, in the Spokane valley. Terminal facilities were acquired in Spokane by the organization of the Spokane Terminal Company, which, in turn, was absorbed by the Spokane & Inland Empire Electric Railway Company as the holding company. The system now has 175 miles of main track and about 60 miles of spurs and sidings. It has the most modern equipment obtainable and is regarded by electrical engineers as one of the best electrical roads in America.

The company also owns and operates an electric power plant on the Spokane river, from which power is transmitted for the operation of the company's street and interurban railway systems. The plant is capable of generating 20,000 horsepower.

Spokane's interurban railway facilities were further extended by the Washington Water Power Company, then a $20,000,000 corporation, constructing a line from Spokane west to Medical lake, 18 miles, and later a branch line to Cheney, 11 miles, making a total of 250 miles of interurban electric road.

Foremost among the electric railway projects in the Pacific States is the Spokane & Inland Empire system, operating 235 miles of main lines and branches in eastern Washington and northern Idaho. When completed this system, now controlled by stockholders of the Great Northern Railway Company, will have extended its tracks into territory not now reached by either steam or electrical lines, as well as not being accessible to tidewater and the Columbia and Snake rivers.

The company operates a power plant at Nine Mile bridge, where the waters of the Spokane river are harnessed to develop 12,000 electrical horsepower for operating railway lines and furnishing light and power. The development of this energy was accomplished by diverting the river from its natural channel, in itself an engineering feat of high order.

The dam is 70 feet thick at its base and 225 feet in length, exclusive of the power house, which is 110 feet wide by 85 feet by 87 feet above low water mark. The river has an estimated average flow of 12,000 cubic second feet. The dam creates a head of water of 60 feet, also backing the river five miles, thus furnishing a storage which will carry large fluctuations of load. The plant will accommodate four 5,000 horsepower units, two of which have been installed. The generators are 3750 kw. three-phase, 2200 volt; 60 cycle alternators. The company also owns a power site just outside the city limits of Spokane, which may be developed in the future.

On the lines now in operation the single-phase system is employed. This is the first of its kind to be operated in the Northwest and it is a success in every way. How it is viewed by electrical experts is probably best summed up in a statement by Geheimrath Wittfield, heading a royal commission of Germany appointed by Emperor Wilhelm, who said, after inspecting the lines and power plants in Spokane, that what he and his associates had seen had more than repaid them for coming across the seas and continent, adding:

"Taking altogether the Spokane & Inland undoubtedly is the best equipped electric railway of equal mileage in the world."

The Washington Water Power Company also operates an electric street railway system in Spokane and furnishes light and power in Spokane, as well as to various points. The company has developed 16,000 of the 60,000 horsepower available at Post Falls and has plants in Spokane and at Little Falls. More than $17,000,000 already is invested in operating plants. In addition it has a 5000 horsepower auxiliary steam plant in Spokane.

The company is installing a power plant at Long Lake, 23 miles north of Spokane, where about $4,000,000 is being invested. The project includes 23 miles of standard gauge steam road, the highest "weir" dam in the world and four turbines, capable of developing 90,000 electrical horsepower, or equalling the capacity of five water wheels at Niagara Falls. The dam is 300 feet in length, 175 feet in height and 150 feet in thickness at the base.

NOVEMBER MEETING LOS ANGELES SECTION A. I. E. E.

The Los Angeles Section of the American Institute of Electrical Engineers will meet on November 21, 1911, when Professor Harris J. Ryan will present a paper on "Polarity in Alternating Current Circuits." At the same time Professor W. A. Hillebrand will present a paper on "Some Fundamental Considerations in the Applications of a System of Graphics to Alternating Current Circuits," this paper constituting an introductory discussion to that of Professor Ryan. Visiting engineers who may be in Los Angeles at this time are cordially invited to be present and to participate in the discussion. In order that those desiring to so participate may be amply prepared in advance these two papers are printed in full in the following pages.

POLARITY IN POLYPHASE CURRENT CIRCUITS.

BY HARRIS J. RYAN.[1]

Introduction.

In 1890 through the efforts of C. E. L. Brown and others the three-phase induction motor and system of electrical power transmission and distribution were developed and introduced in Europe. Simultaneously and quite independently in the United States Tesla and others developed and introduced the corresponding two-phase induction motor and system. The two-phase system promptly encountered in our country the competition of the three-phase system imported by the rivals of the interests in control of the Tesla patents. At the time the expected development of these two systems under an intense commercial rivalry was not a very pleasant thing to contemplate. It was supposed that the machinery and appliances of the one system could not be employed in the other. To cover the business of the country with both systems would mean a duplication of plant and of fixed charges that from the beginning would be too severe a burden for the consumers of electric power to support. As a consequence during the three years that followed, 1891-4, electrical engineers formed two groups, evenly matched in technical and industrial strength and decidedly hostile in regard to these fundamental methods. One advocated the universal adoption of the two-phase and the other the three-phase system for general purposes. Then an extraordinary thing happened. Mr. Chas. F. Scott announced in a paper before the National Electric Light Association his method for transforming from a two-phase to a three-phase circuit, and vice versa. The effect upon the strenuous controversy was marvelous. It was dropped almost in a day.

This was the first result of the study of polarity in polyphase current circuits. One dare say that brilliant as was Mr. Scott's achievement, for he stopped the great battle of the phases, the mental effort he put into it was as a mere trifle compared with the enormous energy that had already been expended in the conflict between the rival camps in their attempt to establish the supremacy of the one system over the other, and with little or no result of positive value. This great victory for the electrical industries was, however, accepted largely as an isolated case, with little conscious realization at the time of the breadth and depth of the underlying principle it involved. To express the relation between the phases, circuits and voltages in his two-phase: three-phase system of transformation Mr. Scott used the familiar T-delta diagram of Fig. a. While the lines in this figure are alternating quantities and therefore vectors, the usual vector arrow heads had to be frankly omitted to avoid manifest conflict in the ideas to be conveyed. It is now seventeen years since this discovery of Mr. Scott was made. To this day for the most part polyphase circuit diagrams of the Fig. a. class are made up of connected lines with their arrow heads omitted; a frank admission that the diagram is incomplete. For example it is well known that the three-phase sources produced at the terminals 1, 2 and 3, by the polyphase current circuits designated in Figs. b, c, d, e, and f, are identical. It required years of trial and effort before we realized our present knowledge of these and similar polyphase circuits. Even now it is a most perplexing matter to those who are not thoroughly at home in this subject to realize that the terminals 1 and 2 in the polyphase circuits Fig. d and Fig. f are sources of voltages, identical in amount and phase positions. This again is due to the fact that while these diagrams are true and correct so far as they go they do not include a designation of all of the essentials that constitute the polyphase circuit because they have omitted the circuit polarities.

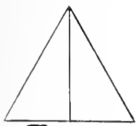


Fig. a.

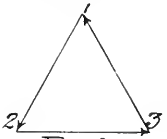


Fig. b.

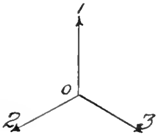


Fig. c.

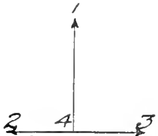


Fig. d.

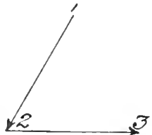


Fig. e.

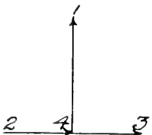


Fig. f.

The general use of direct current began with the development and manufacture of the Gramme dynamo in 1872. There were alternators before that, of a sort, but men did not know how to use alternating currents except to a discouragingly small extent. During the fifteen years, 1872 to 1887, an immense amount of knowledge and experience in direct current working accumulated. In that experience polarity of e.m.f.'s currents and circuits was most everything of importance. Transmission to greater distances forced the development of the transformer from the old Rumkorff induction coil and the introduction of the single-phase system for incandescent lighting in 1885. The demand for a self-starting alternating current motor forced the development of the induction motor from the beautiful rotation experiment of Ferraris, resulting in the practical introduction of the polyphase systems about 1890. There were thus about five years of straight single-phase practice in which the habit developed of neglecting as much as possible polarity in alternating current circuits. The whole nature of things in alternating current working has contributed greatly to deaden the polarity sense, so fully and keenly developed in the direct-current working that preceded the development of the alternating current methods.

The object of the present paper is to contribute toward a development of the polarity sense applied to modern alternating current practice. The polarity sense should not have been neglected during the early introduction of alternating currents. Technical progress would have been made with less expenditure of energy. Our present mental attitude in these matters would be more satisfactory with a stronger development of the relations of polyphase circuit polari-

[1]Professor of Electrical Engineering, Leland Stanford University.

ties. Primarily the effort herein has been to assist those who are now taking up polyphase currents for the first time. The paper was therefore written much in the form of a text and amplified somewhat as such. No effort was made to lessen the task for those who do not care to go so fully into the subject. It is realized, however, that there are many who would like to understand something of the subject and to know to what extent it will pay them to make a study of it. With these facts in mind Professor Hillebrand kindly consented to discuss the paper. The author advises all who are interested in the subject to read Professor Hillebrand's accompanying discussion first and then to take up the text of the paper according to their inclination and needs.

Vector-Circuits:

In the graphic treatment of polyphase currents and their circuits, vectors have to do double duty,—they must express the alternating values and designate their corresponding circuits properly connected. Thus employed they may be called **Vector-Circuits.** Without proper system, irrational use of vector-circuits is easily made and corresponding confusion results. Polyphase current problems in modern practice and the needs of corresponding good teaching now demand a rational and systematic use of the vector-circuit. Some excellent contributions to the literature of this general subject have recently been made.[1] They indicate the arrival of an appreciation of the subject.

It is the purpose of the author to present herewith a text based on a system of vector-circuits that has been developed by him during the past decade in his work of instruction in polyphase currents. It is hoped that all who are prepared to contribute to the subject will do so. This, it is hoped, will lead to the common consent adoption of some one convenient, **rational and standardized system of graphics for the treatment of polyphase currents and their circuits.**

Conventions.

A vector employed to designate an alternating quantity and its circuit is a vector-circuit. In a vector-circuit the vector-length and direction designate the amount and phase of the alternating quantity, while the vector-line with its ends designates the corresponding circuit with its terminals.

A small circle attached near one end of the vector and the usual arrow head indicate that the vector is a vector-circuit, made up of an alternating quantity and its corresponding circuit; the vector-circuit end, toward which the small circle is attached, is the positive terminal of the circuit, and the arrow-headed end determines the positive direction of the vector. See Fig. 1.

A positive direction through a circuit is from the negative to the positive terminal of such circuit.

A positive direction in any closed circuit is taken anti-clockwise.

A vector-circuit is closed "direct" when a positive direction through the closed circuit leads in a positive direction through its corresponding vector-circuit.

Illustrations of the foregoing definitions:

[1] Notation of Polyphase Circuits, by Charles H. Porter; The Electric Journal, Sept., 1907.

A vector-circuit has four signs: a plus and minus sign, each, for the alternating quantity and for the direction in which the circuit is connected.

When letters are used as symbols to designate vector-circuits the first sign of the letter is the sign of the alternating quantity, while the second sign of such symbol is the sign of the corresponding circuit. The reversal of a vector-circuit effects, therefore, no change in the practical effect because in such reversal both an alternating quantity and its circuit have been reversed, a process that always leaves the effect unchanged From this it follows that a **vector-circuit is the exact working equivalent of its equal and opposite vector-circuit.** In the graphic treatment of a community of vector-circuits the working result is not affected by reversing one or all of them.

In Fig. 1, $+e+$ and $-e-$ or $+e-$ and $-e+$ are similar vector-results, while $+e+$ and $+e-$ or $-e+$ and $+e+$ are non-similar vector-circuits. Vector-circuits are similar when their vectors and corresponding circuits have the same terminal relation, viz., the positive ends of all such vectors and circuits coincide or are opposed; they are non-similar when they do not agree in their terminal relation.

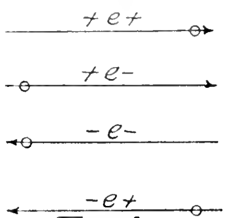


FIG. 1.

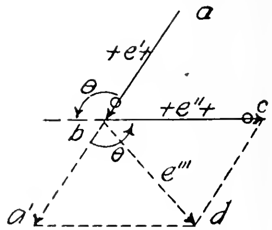


FIG. 2.

Triangulation is a convenient operation to determine results produced by given vector-circuits: operations upon double-vectors by parallelograms and their diagonals are not convenient because the resultant alternating quantities and their corresponding circuits are not coincident as is the case in triangulation.

Triangulation is illustrated in the following example:

In Fig. 2, two e.m.f.'s having a phase difference of θ degrees are written in the usual **vector-chain** fashion, wherein the end of the last vector becomes the origin from which to mount the next vector for a series of e.m.f.'s. In such cases the exterior angle formed at the junction of a pair of vectors is the measure of their phase difference.. The small circles toward the positive ends of these vectors indicate that they are likewise the corresponding containing circuits, thereby constituting them vector-circuits. There is represented in this figure the practical case of an open-delta, three-phase e.m.f. source. What e.m.f. will be delivered between the terminals **a** and **c**? When a loading circuit connects across **ac**, each of the circuits **ab** and **bc** containing the e.m.f.'s e' and e'', is connected into the circuit **abca** thus formed, in a positive direction. Evidently, then, the resultant e.m.f. in the circuit **abc**, applied between the terminals **ac**, will be the vector sum of the e.m.f.'s, e' and e'', just as they stand. Such sum is e''', vector **bd**, Fig. 2, obtained in the usual manner by means of the diagonal of the proper paral-

lelogram. By construction, the distance, **bd**, is equal to the distance, **ac**, which closes the triangle formed on **e'** and **e''**. **e''' = bd = ac** might be drawn as a vector from **a** to **c** to express the result, i.e., the e.m.f. impressed between **a** and **c** by **e'** and **e''**. **However, this is a vector-circuit diagram wherein every line represents not only an alternating quantity but its conducting circuit as well,—it will not do, therefore, to connect ac with a vector to express the resultant e.m.f. which occurs, not in the circuit ac, but in the circuit abc. It will be legitimate, however, to connect ac with a conducting circuit provided it contains an e.m.f. that is the equal and opposite of that which is applied a and c by the resultant of e' and e'' in abc.** Since such vector-circuit **e''' = ac** is the working equivalent of **e' + e'' = abc** (neglecting internal impedance), it may be joined in multiple with **e' + e''** at **a** and **c** without disturbance in the practical case. It will deliver current to an external loading circuit connected to **ac** just the same as will **e' + e''** in **abc**. In their Fig. 2

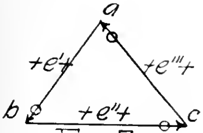


FIG. 3.

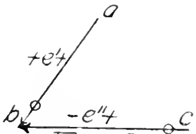


FIG. 4.

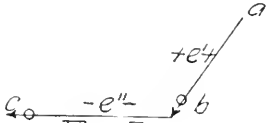


FIG. 5.

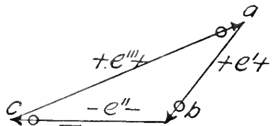


FIG. 6.

relation, **e'** and **e''** are redrawn in Fig. 3 and their anti-resultant **+ e''' +** is drawn as the double-vector closing their triangle.

This process in vector-circuits for obtaining the anti-resultant is called triangulation.[1]

Similar vector-circuits are properly subject to triangulation, while **non-similar** vector-circuits demand operation by parallelogram-diagonals to get their resultant; such diagonals do not register the proper connections for their circuits. The conclusion, therefore, follows that the determination of the resultants of vector-circuits must be accomplished by triangulation as demonstrated above.

Since triangulation may be applied to communities of similar vector-circuits only, communities of non-similar vector-circuits can be operated upon by triangulation only after they have been re-expressed in their equivalent communities of vector-circuits that are similar. Operations upon non-similar vector-circuits to reduce them to similar vector-circuits:

The non-similar vector circuit, **abc**, in Fig. 4, is to be transformed to a circuit of equivalent similar double-vectors. Let **+e' +** remain as it is. Reverse the connection of the circuit of **e''** with respect to that of **e'**, at the same time reverse the alternating value of **e''** with respect to its circuit. A double reversal has been made and the working result has not been changed. This has been done in Fig. 5 where triangulation is now practicable and **+e''' +** has been found to be the anti-resultant or equivalent e.m.f.-circuit of the circuit **abc** containing the e.m.f.'s **e'** and **e''**; see Fig. 6.

[1]At the close of this paper a method is given for identifying actual circuits, e.m.f.'s, etc., and their corresponding double vectors, so that the latter may be a guide in making real circuit connections.

It is well to remember that the practical cases designated by the original e.m.f.-circuit **abc** in Fig. 4 and the one in Fig. 5 are actually different, though the duties they will render are identical. The e.m.f.'s **e''**, Fig. 4 and Fig. 5, are opposite and their circuits have been correspondingly reverse-connected. The original is not subject to triangulation and the use of a properly chosen equivalent of similar vector-circuits is an expedient that permits triangulation to determine the desired equivalent resultant.

Current Tapped From a Junction of Two Alternating E. M. F.'s Differing in Phase.

A polyphase current circuit and therein two e.m.f.'s **e'** and **e''**, differing in phase, are designated by means of a pair of corresponding double-vectors, **+ e' +** and **+ e'' +** in Fig. 7.

A conductor **bd** is connected so as to tap current from the junction of the two current sources at **b**, which is, therefore, the graphic origin of the common loading circuits. The loading circuits must be mounted so that their relations to the common tap-conductor **bd** are similar. This is done by branching them from the end of the tap-conductor in a positive or anti-clockwise direction through the proper loading resistance **r'** and **r''** to the other source terminals, **a** and **c**, respectively. The loading resistances

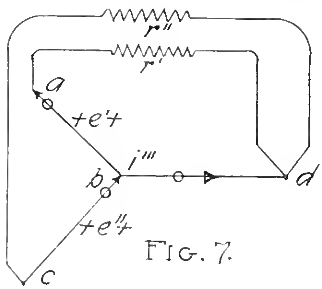


FIG. 7.

are taken non-inductive; the corresponding procedure when loading at a power factor less than unity will be obvious. The currents **i'** and **i''** in the circuits **bdr'ab** and **bdr''cb** are in phase with their corresponding e.m.f.'s **+ e' +** and **+ e'' +**. A study of these circuits reveals the fact that the e.m.f.-circuit **ba** is connected in its loading circuit reversed while **cb** is connected direct. To understand the phase-relation of the currents **i'** and **i''** in the tap-conductor or **bd** which has a similar relation to the loading circuits in which it performs common duty it will be necessary to bring the source e.m.f.-circuits into the same connective relation to their loading circuits, and, therefore, to the tap conductor. The e.m.f.-circuit **cb + e'' +** is already

in standard or positive relation to its closed loading circuit. To bring $+e'+$ into a similar relation with its closed loading circuit, it must be completely reversed, an operation, as shown above, that causes no change in the practical result, but which will cause this e.m.f.-circuit to have a direct, in lieu of a reversed, connection in its loading circuit.

This has been done in Fig. 8. All connections are now made similar by operations that do not change the result. The resulting current in the tap-conductor **bd**, or **i‴**, is therefore, readily obtained, correct in amount and true in phase position, by the ordinary geometric addition of its parts **i′** and **i″**. The current-vector **i‴**, in Fig. 8 may now be remounted without change in Fig 7, using **b** as its origin to express the total current set up through the tap **bd** and the specified loading circuits by the polyphase e.m.f.'s $+e'+$ and $+e''+$.

Using the same pair of e.m.f.-circuits and with phase-circuit relations varied through the range made possible by reversals of one or both e.m.f.-phases, one or both circuits, or by total reversal of one or both e.m.f.-circuits, the several different double phase sources of

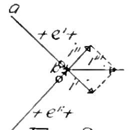


Fig. 8.

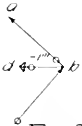


Fig. 8-a.

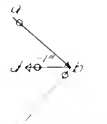


Fig. 8-b

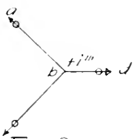


Fig. 8-c

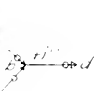


Fig. 8-d

Fig. 8-e.

current to be tapped from the junction point **b** are formed and designated by corresponding vector-circuit diagrams in Figs. 8a, 8b, 8c, and 8d. Applying the above method to determine the current in the tap-conductor, such current is found to be **i‴**, the same in amount as in the first instance for all cases and the same in phase for Figs. 8c and 8d and of opposite phase for 8a where the circuits were reversed and for 8b where the e.m.f.'s were reversed.

The foregoing combinations did not include those that can be made up so that they must be designated by non-similar vector-circuits. Fig. 8e relates to one of these combinations that has to be designated by non-similar vector-circuits. It is the same as that in Fig 7 except that the terminals of the **ab** em.f.-circuit have been reversed. Going through the method to determine the current tapped through the conductor **bd** and the same corresponding loading circuits continued to **a** and **c**, it is found that the circuits **ab** and **cb** are now both connected direct in their loading circuits, the currents they establish make a direct combination through their common tapping conductor **bd** and must be combined geometrically as they occur to form **i‴**. Fig. 8e, which differs from the foregoing resulting currents in both amount and phase.

Practical Examples.

With the foregoing understanding of the principles that govern the use of vector-circuits it is a simple matter to reconcile the polyphase vector diagrams given in Fig. 9, 10, 11, 12 and 13.

In Fig. 9 the topographic points of alternating potential **abc** are the result of a delta connected three-phase source of e.m.f.'s shown by the corresponding delta of vector-circuits. In the cases given in Figs. 9, 10, 11, 12 and 13 **abc** are in each instance identical potential points produced by the same identical e.m.f.'s applied direct in Fig. 9 and in the other cases as resultants quickly found by triangulation. In days past one of the great difficulties in the graphic study of polyphase currents has been to reconcile the fact that the e.m.f.-circuits of Figs. 11 and 13 deliver identical potentials at the terminal points **abc**. In Fig. 14

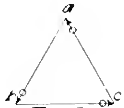


Fig. 9.

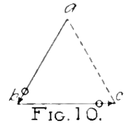


Fig. 10.

Fig. 11.

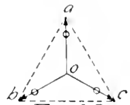


Fig. 12.

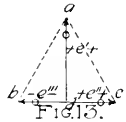


Fig. 13.

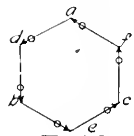


Fig. 14.

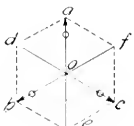


Fig. 15.

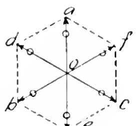


Fig. 16.

vector-circuits designate the delivery of a six-phase alternating potential at the current tapping points **adbecf**. These e.m.f-circuit sources are mesh-connected. In Fig. 15, three three-phase e.m.f.-circuits are star-connected by connecting all three midcircuit points. In Fig. 16, six six-phase e.m.f.-circuits are star connected, these e.m.f.'s have each one-half the values of the three-phase e.m.f.-circuits in Fig. 15. In all three cases, Figs. 14, 15 and 16, the topographic potential points are identical; vector-circuit triangulation in Figs. 15 and 16 shows that the star-connected three and six-phase e.m.f. sources deliver six-phase potentials at **adbecf**, identical with those delivered by the six-phase mesh-connected e.m.f.-circuits in Fig. 14.

To assist the reader in applying triangulation to the double-vectors that designate open delta or star-connected e.m.f.-circuits the details of the process will be repeated for the two cases given in Figs. 11 and 13.

In Fig. 11 it is first desired to find by triangulation the e.m.f.-circuit that is the working equivalent $+e'+$ and $+e''+$ applied in series through **adc**. Taking a positive direction through the closed circuit **adca**, it is found that the circuit **dc** is connected direct and **ad**, reversed. By reversing the vector-circuit $+e'+$ no change in the working result is effected

while its circuit is made to be direct connected. This operation has been performed in Fig. 17. Since both e.m.f.-circuits are now direct connected to the closed circuit **adca**, the e.m.f. may be added in the usual manner. The result of such an addition is the vector **a** directed to **c** and its equal and opposite or working equivalent is **c** directed to **a**. The vector-circuit $+e''''+$ as drawn in Fig. 17 is, therefore, the working equivalent of the values $+e'+$ and $+e''+$ as given in in Fig. 11. In the same manner, in Fig. 11, it is seen that the e.m.f.-circuits **bd** and **da** are direct connected in the closed circuit **abda**, and the equal and opposite e.m.f.-circuit of $+e'+$ and $+e'''+$ is $+e'''''$, as given in Fig. 18, which gives the results of both triangulations and which shows that the potentials at **ab** and **c**

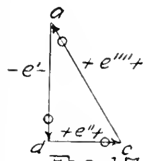


FIG. 17.

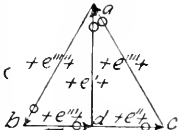


FIG. 18.

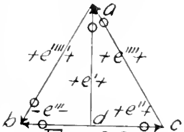


FIG. 19.

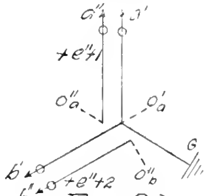


FIG. 20.

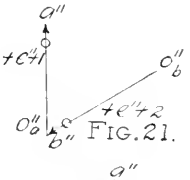


FIG. 21.

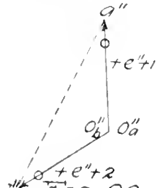


FIG. 22.

are those due to the three-phase e.m.f.'s e'''', e''''' and $e'''+e''$ and that they are identical with the three-phase e.m.f. given in Fig. 9. In the Fig. 13 case, $-e'+$ and $+e''+$ occupy a relation to the tapping points, **a** and **c**, that is identical with that in Fig. 11; the result is, therefore, the same. Taking a circuit in a positive direction through $-e'''$ and $+e'+$ it is found that the circuit of $-e'''$ is reverse connected. Upon reversing the vector-circuit, i. e., changing $-e'''$ to $+e'''+$, it is seen that the anti-resultant or working equivalent vector-circuit for $+e'+$ and $-e'''$ is $+e'''''+$. The completed triangulation is given in Fig. 19.

One more practical example illustrating the use of double-vectors will be a help: It is desired to know how to connect in an emergency the secondaries of two transformers tapping their primary currents to ground from one pair of conductors of a three-phase line operating with a grounded neutral so that the two secondaries will constitute an open-delta three-phase source. In Fig. 20 are given the vector-circuits for the corresponding primary and secondary e.m.f.-circuits.

In Fig. 21, a secondary open-delta connection has been formed by connecting the terminal o''_a to b''. By triangulation it is seen that a three-phase e.m.f. will be delivered from the current tapping-points a'', $o''_a b''$ and o''_b. The phases of the two secondary e.m.f.'s necessarily remain unchanged; to do this and to retain similar vector-circuits so that their working equivalent would close their triangle and thus make a proper three-phase open delta, it was necessary to reverse one pair of terminals b'', o''_b connecting o''_a to b'' instead of o''_a to o''_b corresponding to the primary connection of o'_a to o'_b.

If the connections had been made without the reversal of one of the secondaries, the result would be that given in Fig. 22.

Another practical problem is this: Given three sources of e.m.f. differing in phase by one-sixth of a cycle. They are to be connected to form:

1. Delta three-phase source.
2. Y three-phase source.

The vector-circuits for the three original e.m.f.'s and their corresponding circuits are given in Fig. 23.

Without alteration these vector-circuits are thrown into a triangle in Fig. 24. The result is a delta-connected three-phase source of e.m.f. in which the phase interval is one-third instead of one-sixth cycle. To one unaccustomed to the properties of vector-circuits this diagram does not appear correct. It turns up correct, however, if one remembers that the result is not changed when the double-vector $+e'''+$ is completely reversed in place. This delta-connection of

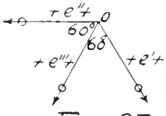


FIG. 23.

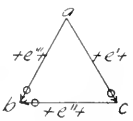


FIG. 24

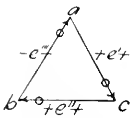


FIG. 25.

Fig. 24 will also stand the test that all proper delta-connected e.m.f.'s must stand, viz:

1. The sum of three e.m.f.'s is zero.
2. By triangulation each e.m.f. is found to be the anti-resultant of the remaining two.

In applying these two checks it is convenient to have $-e'''-$ substituted, as in Fig. 25 for $+e'''+$, as in Fig. 24, though it must be remembered that the Fig. 25 connection is not identical with the Fig. 24 connection, and that in any event it is a connection that produces an equivalent result. In making connections nothing can be done to change the actual phase of the e.m.f. e'''; the only change that can be made is to reverse the terminals changing $+e'''+$ to $+e'''-$. In the practical case having identified the directions of the e.m.f. vectors and the positive ends of their circuits and having labeled the actual corresponding positive terminals of the real e.m.f.-circuits in the alternator, one may easily read from the vector-circuit triangle, Fig. 24, that one of the three junctions, **e**, forming the delta connection is made by con-

necting the positive end of the **e′** circuit to the negative end of the e″ circuit: junction **b**, the positive ends of the e″ and e‴ circuits: and junction **a**, by the connection of the negative ends of **e‴** and **e′**.

The three-phase Y-connected sixth cycle set of Fig. 23 is given in Fig. 25a.

From Fig. 25a one reads that the negative end of the e‴: circuit and the positive ends of the e′: and the e″: circuits are connected to neutral. It must be understood that this is the only correct way to designate this connection of the original e.m.f.: circuits as given. To substitute —e′— and —e″— for +e′+ and +e″+ would produce a diagram more like the Y-connection sort that one is accustomed to see, and **while it would be a working equivalent it would not represent the facts and would not tell one properly how to make the practical connections.**

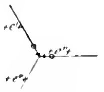


Fig. 25-a.

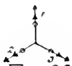


Fig. 26.

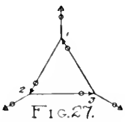


Fig. 27.

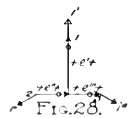


Fig. 28.

Proper Designation of Current Tapped from Polyphase Sources.

In the star-connected three-phase case in Fig. 26, there is no doubt about the proper designation of the currents drawn from the loading points 1, 2 and 3. The currents tapped from the junction points in the delta-connected three-phase source are designated as determined above. Owing to the fact that the Y, delta and T-connections of Figs. 26, 27 and 27, produce identical topographic results, it is reasonable, therefore, to expect that the same line currents drawn from either three-phase source should be designated by the same current vectors. The loading currents for the T-connected source in Fig. 28 are drawn the same, therefore, as for the two preceding cases.

To one to whom the properties of vector-circuits are new the phase of **i** in this case does not look reasonable because it seems to make the +e″+ circuit a negative instead of a positive source of power. With more thought, however, it is seen that +e″+ is reverse-connected in the closed loading circuit extending from terminal No. 2. A reversal of +e″+ does not alter the working result while it causes the resulting —e″— circuit to be direct connected to its closed loading circuit; it is thus seen that this section is a positive source of power. Again, going over the details involved in determining the current at 2, using Fig. 29, will assist further to understand that the i″ power component is in phase with +e″+ and not in phase opposition.

The current drawn through a transmitting conductor from terminal No. 2, has components due to the two sources that meet at this point and deliver therefrom current through their respective loading circuits. To determine these component currents in their proper phase relations, extend, (front view) i. e. in a positive or anti-clockwise direction the two loading circuits from the line conductor connected from terminal 2 through their respective loading resistances $r_{1:2}$ and $r_{2:3}$ to the other phase-terminals 1 and 3. In the $r_{1:2}$ circuit, current is set up by +e′+ and +e″+, both reverse-connected in their closed loading circuit. On totally reversing both, which does not alter the working result, it is seen that the value and phase of their resultant e.m.f. is given by the vector directed from 1 to 2, the corresponding current established by this resultant e.m.f. is $i_{2:1}$ as drawn. Likewise in the $r_{2:3}$ loading circuit both e.m.f.'s-circuits +e″+ and +e‴+ are reverse connected. Upon total reversal of their double-vectors they become direct connected when it is seen that their resultant e.m.f. impressed from 2 upon their loading circuit is given in amount

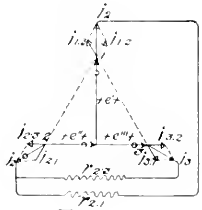


Fig. 29.

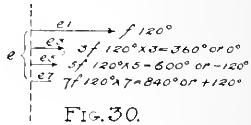


Fig. 30.

and phase positive by a vector directed from 3 to 2 and the corresponding current established is $i_{2:3}$. The total current is the geometric sum of these two component currents **i.e.**, i_2 as drawn. In the same manner the current-vectors at the other three-phase tapping points 1 and 3 may be determined, and when done will be found also to agree with current-vectors set up from the star-connected source in Fig. 26.

Vector-Circuits in the Treatment of Non-Sine-Wave Poly-phase Currents.

Every polygon or mesh-connected poly-phase current source forms a closed conducting circuit within which the sum of all e.m.f.'s at every instant must be zero. When such is not the case, internal "circulating" currents are set up by the residue e.m.f. that results from the imperfect balance of the poly-phase e.m.f.'s. Every non-sine wave is simply an aggregation of waves differing in amounts and frequencies in a manner now well known. The general effect of this will be better understood by looking at a particular case. To do this use a delta-connected non-sine wave three-phase case. The multi-frequencied components of the wave employed are given in Fig. 30.

In Fig. 31, diagram **A** is a vector-circuit delta for the fundamental component e.m.f.; **B** is the corresponding connection for the three-frequency component—e.m.f.—mutilated by being left open at the tapping point **aa** because the phase interval of these e.m.f.'s is zero. **C** is the corresponding connection for the five-frequency component—e.m.f., not mutilated but resulting in a reversal of sequence of e.m.f.-phases, the effect of which, for example, would be to make an effort to reverse the rotation of an induction motor. In **D**, the seven-frequency e.m.f. component produces the same sort of result as the fundamental.

It is apparent that the three effective e.m.f. vectors that express the total e.m.f.'s resulting from a combination of the one, five, seven, eleven, thirteen, etc. frequency e.m.f.'s in the general case will have equal but larger values than the fundamental and that their

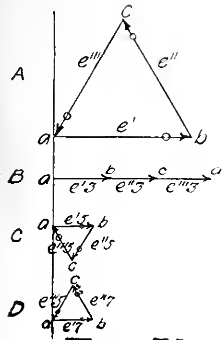


FIG. 31.

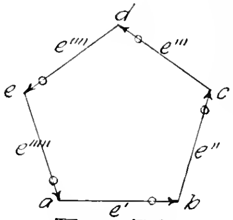


FIG. 32.

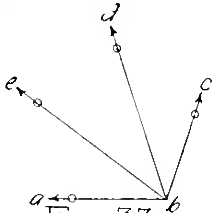


FIG. 33.

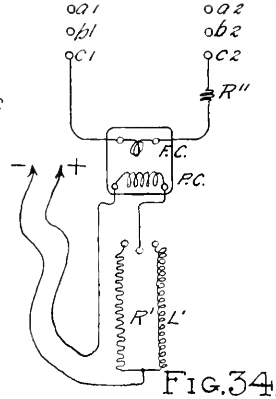


FIG. 34.

phase intervals will be unchanged. It follows that the equivalent sine wave values of total non-sine wave e.m.f.'s and their circuits may be designated by corresponding vector-circuits which may be operated upon in the usual manner to attain desired and correct results so long as those multi-frequencied component e.m.f.'s are absent which do not occur at the same phase interval as the fundamental.

In the foregoing three-phase case, the three, nine, etc. frequency component e.m.f.'s do not have the phase interval of the fundamental and no delta or receiver closed source connection containing those e.m.f's can be correctly represented by vector-circuits because they produce a phase interval for the vectors designating the total effective e.m.f.'s that is different from the phase interval of the fundamental; the source circuit will fail to close by an interval that is equal to the sum of the offending harmonics. As an example, suppose that the three-frequency harmonic is the only offending one, present. It will increase the three total effective e.m.f.'s to the same extent as though quadrature sine-waves having the same frequencies, were being combined. The results when represented by corresponding vector-circuits will show graphically a failure to close the delta, yet the gap thus determined will not be equal to the arithmetic sum of the in-phase three-frequency components nor will it have their phase. In the practical case, however, the circuit-triangle is actually closed and then the offending harmonic e.m.f.'s are consumed by circulating currents internally causing the external disappearance of such offending harmonics. Practicably, with this understanding, vector-circuits may be used to designate all e.m.f.-circuits; and such vector-circuits may be operated upon to give correct results just as though simple sine-waves were employed. An illustration of this is found in the following graphic

Vector-Circuit Proof of the n-1 Wattmeter Power-Measuring Method.

A five-phase closed polygon-connected irregular wave alternating current-source is designated by corresponding double-vectors in Fig. 32. There may be internal circulating currents in this case due to the non-conformity to such a connection of some of the harmonic component e.m.f.'s, yet, it is true, that a fan-connected set of four non-sine-wave e.m.f.'s may be employed to duplicate exactly the topographic potentials at the line tapping points **abcde,** as drawn in Fig. 33, when it becomes evident at once that any power delivered from those points may be measured by taking the sum of the indications of four wattmeters connected in the outgoing conductors at **cde** and **a**; the conductor at **b**, acting as a common return.

Since the validity of the **n-1** wattmeter methods has been established by various independent mathematical treatments, its above application, working backward, constitutes a check upon the conclusion that vector-circuits may with proper recollection of the underlying principles involved, be applied to non-sine as well as sine-wave cases.

Identification of Actual Circuits for the Application of Vector-Circuits.

First, all original e.m.f.'s and their phases, circuits, and their terminals should be identified, vector-circuit fashion, by some such method as that applied in the following particular case:

In Fig. 34, a_1 a_2, b_1 b_2 and c_1 c_2 are the terminals of three current sources. To identify them for vector-circuit designation, connect a non-inductive loading resistance **R''** between the terminals of one of the sources c_1 and c_2 through the field coils of a suitable wattmeter.

The current through the voltage coil must have a dual control; an in-phase control by the usual non-inductive resistance and a quadrature-lagging control by the special form of inductance, such as commonly used in induction meters. By means of a proper switch, either voltage control can be employed at will to read on the wattmeter the voltage components that are in phase and in quadrature with the standard phase-current drawn through **R''** and the wattmeter field coil at **FC.** Label arbitrarily the wattmeter voltage circuit terminals + and —. Using the non-inductive control in the instrument voltage circuit, apply its labeled ends to the source terminals so that the instrument will read positive. That terminal c_1 or c_2, to which the positive end of the pressure circuit has been applied should be labeled **positive.** The reading of the instrument is proportional to the in-phase

pressure applied between c_1 and c_2 and determines, therefore, the amount and phase of the corresponding vector; the corresponding vector-circuit is drawn in Fig. 35. The instrument voltage, circuit-ends, using in-

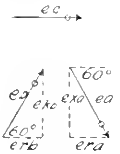


FIG. 35.

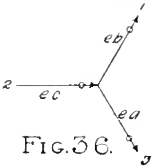


FIG. 36.

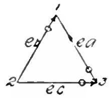


FIG. 37.

phase control, are now applied to b_1 and b_2 so that the instrument reads positive. The terminal b_1 or b_2 receiving the + end from the instrument is labeled **positive.** The reading e_r, is the postive in-phase component of e_b. The lagging quadrature control is now substituted in the instrument voltage circuit when the instrument reads positive by the amount e_k, the **leading** quadrature component of e_b. Thus the vector-circuit for e_b is located. See Fig. 35. It was found to lead e_c by 60°. In the same manner the $a_1 a_2$ terminals were identified and e_a was located and found to lag with respect to e_c by 60°. Its corresponding double-vector is drawn in the same figure.

It is now required to determine:

1. How to three-phase: Y-connect these e.m.f.-circuits.

Operating on their unchanged vector-circuits, there are two ways to throw them into the Y-form. One of these is given in Fig. 36.

At first glance this may look like a genuine three-phase Y or star-connected three-phase current source. That such is the case is seen at once, however, when it is remembered that the total reversal of e_c will not change the working result but will give us that which we know to be a real three-phase source. In the practical case we can only reverse the circuit terminals of e_c we cannot reverse the phase of its alternating value; we must let e_c in Fig. 36 stand as it is and as such the connection is **a true Y-three-phase.** To realize it practically, the negative terminals of the circuits $a_1 a_2$ and $b_2 b_1$ and the positive of terminal $e_1 e_2$ must be connected to neutral.

2. How to three-phase: delta-connect these same e.m.f.-circuits.

Again operating on them unchanged, there are two ways in which they can be thrown into a delta-form. One of these is given in Fig. 37, which is recognized as a proper delta-connected three-phase source when e_c is totally reversed. As it is, it accomplishes the same result, and must remain unchanged because in the practical case total reversal cannot be accomplished, the circuit terminals only can be reversed and that would produce a failure to form a three-phase source-circuit. The diagram is, therefore, correct for the formation of a true delta-connected three-phase source and states that the negative terminal of the e_a and the positive of the e_b, the negatives of the e_b and e_c and the positives of the e_c and e_a circuits must be connected to form the three-phase current tapping points 1, 2 and 3.

SOME FUNDAMENTAL CONSIDERATIONS IN THE APPLICATION OF A SYSTEM OF GRAPHICS TO ALTERNATING CURRENT CIRCUITS.[1]

BY W. A. HILLEBRAND.[2]

The purpose of the graphical representation of polyphase electromotive forces and currents is to facilitate the interpretation or predetermination of the result obtained by combining any number of electromotive forces into a polyphase network. In their present state our graphical methods, when applied to actual instead of to imaginary circuits, largely fail in both of these requirements because they offer no opportunity for representing apparatus or circuit terminals, whereas, the phase of a given e.m.f. with respect to the phase of other electromotive forces with which it may be connected, is, to an important degree, dependent upon the order in which its terminals are connected into the circuit.

Before presenting a system which, it is believed, will satisfy these two conditions, some of the difficulties inherent in a scheme that undertakes to recognize the circuit terminals as well as their electromotive forces, will be dwelt upon.

The first of these is a satisfactory definition of the term "phase difference" or "phase relation," as applied to actual, physical circuits.

Definition of Phase Relation.

The phase difference between two e.m.f.'s is the time interval, expressed as a fraction of a cycle or in degrees, between the instants when each would begin to send current through its own circuit from one specified terminal to another. Accepting this definition, it is seen that the phase relation of one e.m.f. with respect to another is dependent upon the arbitrary choice of terminals and of a direction of reference from one terminal to another. Accordingly, each circuit will be assumed to have a positive and a negative terminal, arbitrarily chosen, and the direction of reference will be from the negative to the positive terminal.

In accordance with these conventions the phase difference between two e.m.f.'s may be defined as the time interval, expressed in degrees, between the instants when each would tend to circulate current from the negative to the positive terminal through its own circuit.

If ab and cd, Fig. 1, are two transformer secondaries with arbitrarily selected + and — terminals as shown, and if, one sixth of a cycle after ab commences to circulate current from a to b via route a T b, cd commences to circulate current from d to c, via dTc, then cd may be said to lag 60° behind ab. If c and d had been marked — and + respectively instead of + and —, then e.m.f. cd would lead ab by 120° instead of lagging by 60°.

[1]What follows is intended as a discussion of Professor Ryan's paper on the "Graphic Treatment of Polyphase Current Circuits." It was prepared at his suggestion in the hope that an explanation of the difficulties encountered therein would help others similarly troubled, to an understanding of the fundamental principles underlying his conventional treatment. For the sake of clearness it was considered best not to pad the treatment itself with too much explanatory matter.

[2]Professor of Electrical Engineering Oregon Agricultural College.

Symbols.

Since phase relation has been defined with reference to a direction through the circuit, the vector line that represents the alternating quantity must also indicate the circuit terminals. Thus, a chain of such vectors will represent not only the magnitude and phase of the alternating quantities, but the circuit connections as well. The circuit terminals may be indicated by placing a small circle near that end of the vector which represents the positive terminal of the circuit. The other end of the vector line is understood to be the negative terminal.

Accordingly, the e.m.f. and circuit ab of Fig. 1 may be represented as in Fig. 2 or as in Fig. 3, since there is no reason initially for associating the positive or arrowhead end of the vector with the positive terminal of the circuit.

Since cd has been assumed to lag behind ab by 60°, it may be represented as in Figs. 4 and 5, according to the direction assigned to ab. For the same reason there is a choice, in each case, between two ways of writing the vector.

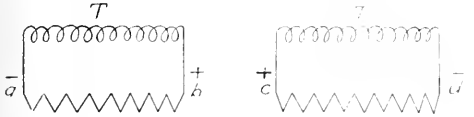
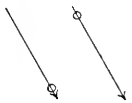


Fig. 1.

Fig. 2.

Fig. 3.



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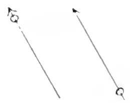


Fig. 5.

Suppose now that b and d are connected together and a and c joined to a loading circuit as in Fig. 6. One sixth cycle, or 60° after ab commences to circulate around in the direction abdcyx, cd commences to do the same thing. We have across xy the resultant of two e.m.f.'s 60° apart. Their sum, written in the conventional vector fashion, wherein the vectors represent only the alternating quantities, is xy, Fig. 7.

Employing the double vectors of Figs. 2, 3, 4 and 5, the connection of Fig. 6 may be represented in either of four ways, Fig. 8. Each of these four diagrams correctly represents the facts of Fig. 6, namely, that cd lags 60° behind ab and that the positive terminal of the circuit ab is connected to the negative terminal of cd. Yet in only two of the four cases does the closing side of the triangle correctly represent the resultant of the two electromotive forces.

In Figs. 8, b and c, it will be noted that the vector arrowheads meet. In such a case the closing side of the triangle can not give the resultant of the vector combination. In order that the closing side will also give the resultant, arrow head must connect with arrow foot, which will always be the case, after due account has been taken of circuit connections, if, the vectors are all so chosen that the positive or arrow head end of each vector is associated with the positive terminal of its circuit. The positive ends of the vectors might, with equal justice, be associated with the negative terminals of their circuits, provided the arrangement applies throughout. Thus, in Fig. 8, the e.m.f. circuit cd should be represented as in Fig. a or d.

Reversal of Vector.

The phase interval between the two e.m.f.'s has been defined independently of their connection into a common circuit, yet when so connected, it is necessary to consider their phase interval as largely determined

Fig. 6

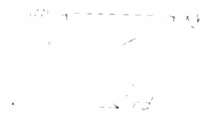


Fig. 7

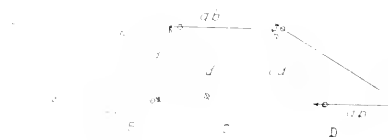


Fig. 8.

by the order of such connection. However, once the phase relation is known for a given set of conditions, it can be readily determined for any other set of conditions, which is the reason for the definition previously given.

Let b and c be connected as in Fig. 9 and let the direction of reference around the circuit be adcdyx. This direction leads through ab from — to +, in the same order as in Figs. 1 and 6, but leads through cd in the opposite direction. This means that the phase of ab is unchanged, but that of cd is reversed, because the direction of reference through cd is opposite to what it was formerly. This is in accord with the physical facts, for cd now commences to circulate current in the direction abcdyx 120° before ab commences to do the same thing. That is, cd now leads ab in its

effort to circulate current through a common circuit. Vectorially, the condition is represented in Fig. 10.

Using the vector relation between ab and cd as originally assumed, the connection is represented in Fig. 11, where the direction of the resultant is obtained as in Fig. 10, by reversing cd.

The question then arises, how to tell when to reverse a vector in order to obtain the correct phase position of the resultant.

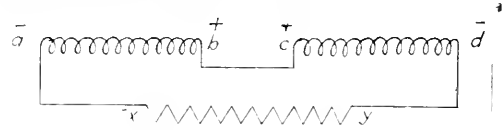


FIG. 9.

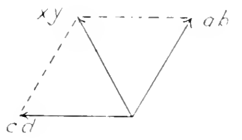


FIG. 10.

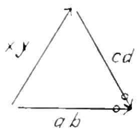


FIG. 11.

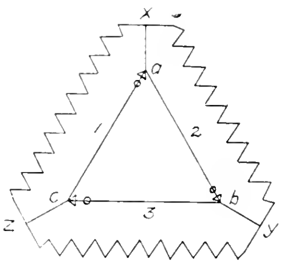


FIG. 12.

Phase relation has been defined on the basis of an effort to circulate current from a negative to a positive terminal. If a series of e.m.f.'s have alternately plus and minus terminals connected, that is, if the succession of terminals in going around the circuit is — + — + etc., then the order in which each e.m.f tends to circulate current in given direction through their common circuit is the same as the order in which each would circulate current through a separate loading circuit of its own. That is, the phase position of each e.m.f. as originally determined is, in effect, unchanged by its connection into this circuit.

This is the case in Figs. 6, 8a and 8d.

If, however, one circuit should have been so connected that two minus and two plus terminals come together, then the order in which it tends to circulate current through the common circuit is different from the order determined by its separate loading circuit. The effect of reversing the connection has been equivalent to reversing the phase of that circuit.

This is the case in Figs. 9 and 11, in which, starting with terminal "a," circuit cd is found to have been reversed. As a matter of fact, the resultant would have been obtained just as readily by reversing ab, the succession of terminals indicating merely that one vector must be reversed to give the true direction of the resultant.

Choice of a Standard Direction Around a Circuit.

In the two previous cases the circuit ab was taken as a standard and any circuit found reverse connected with respect to it was reversed in the vector diagram. An arbitrary assumption of one vector as a standard of reference is necessary in all cases, but procedure is simplified if, instead of picking out a particular vector each time, the circuit is traversed in one direction, in this system taken as counter clockwise. Any vectors passed through from — to + are assumed direct connected and automatically become the standards of reference. All others must be reversed in determining the direction of the resultant.

Placing of Loading Circuits.

In applying this rule to determine the phase relation of the current drawn from the junction of two circuits, there is one precaution to be borne in mind, which will be illustrated by an example.

Fig. 12 represents three-phase currents, mesh connected, it being desired to determine the phase relation of the current in tap conductor ax. The diagram shows that at a time interval of 120° after current starts to circulate from phase 1 around caxzc, current from phase 2 starts to circulate around byxab. That is, 120° after current in phase 1 starts to flow from a to x, current from phase 2 starts to flow from x to a, or current from phase 2 starts to flow from a to x 60° earlier than current from phase 1. Since phase relation of current or e.m.f. in a given circuit can only be determined on the basis of an assumed direction from one terminal to the other, the two currents in ax are found to be 60° apart.

This could have been determined directly by mounting the loading circuits as in Fig. 13.

Now, in traveling around the two circuits caxzc and axyba, each in the positive direction, circuit ax is passed through in the same direction each time. Current ab is now found to be reverse connected. Hence its phase position with respect to current ca in ax is leading by 60°. The current in the tap conductor ax, to a different scale, is shown in Fig. 14.

In determining the phase position of the current in a tap conductor, the loading circuits must be so placed that in traversing each of the circuits furnishing a component of current in a counter clockwise direction, the common or tap circuit is passed through each time in the same direction.

It is of interest to note that had the direction of reference been taken from x to a, in Fig. 12, the phase position of current in ax would be that given in a of Fig. 15. Thus the three phase line currents in a

mesh connected system can with equal justice be represented as in either b or c of Fig. 15, inconsistent as these two diagrams may at first appear.

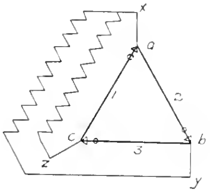


FIG. 13.

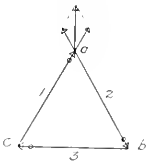


FIG. 14.

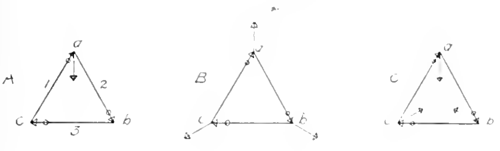


FIG. 15.

In a system wherein every vector represents not only an alternating quantity but its circuit as well, the closing side of any vector polygon must be equivalent to the anti-resultant of the other vectors or else a short circuit will result. This anti-resultant may be represented as ac in either of Figs. 16 or 17, but in a conventional diagram, for the sake of symmetry, the form of Fig. 17 is considered preferable. In some of the previous diagrams, where resultants have been employed, they have been drawn separate from the rest of the diagram, to indicate that actual connection is not intended.

Summary.

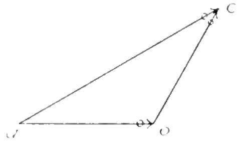
The salient points which the foregoing discussion has endeavored to develop are the following:

Phase relation between electromotive forces or currents must be based upon an assumed direction through the circuit under consideration.

It is necessary to have a symbol which will represent both the alternating quantity and its circuit terminals.

It is desirable to so choose the symbols representing a group of alternating quantities that all of the positive circuit terminals are associated with all of the positive vector terminals, or else with all of the negative vector terminals. For instance, it is awkward to work with the vectors of a group of circuits, some of which have the positive ends of the vectors associated with the positive circuit terminals, while others have the positive vector ends associated with the negative circuit terminals.

The phase relation of several interconnected, alternating quantities may be determined with regard to their common circuit by traversing that circuit in a positive or counter-clockwise direction. Each individual circuit which, in this process, is passed through from its negative to its positive terminal, is taken as the standard of reference, and its phase position is



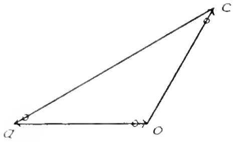


FIG. 16. FIG. 17.

assumed to be unchanged. All circuits passed through from positive to negative terminal thereby become reverse connected and their vectors must be reversed in determining the resultant.

In determining the value and phase relation of the current in a tap conductor at the junction of two circuits, it is convenient to so locate the loading circuits that in following around each circuit in a positive direction, the tap conductor is each time traversed in the same direction.

Since each vector represents a live circuit, the closing side of any vector polygon must be equivalent to the anti-resultant of the other circuits.

PROPOSED PANAMA TRIP.

The Board of Directors of the American Institute of Electrical Engineers has under consideration the suggestion of arranging for a trip of inspection to the Panama Canal Zone during the coming winter.

The work on the canal has reached such an advanced stage that by May, 1912, the authorities expect to begin flooding the Gatun Lake and letting water into the various levels of the canal. Therefore, this coming winter will afford the best, and also the last, opportunity of inspecting the work, as it will have approached completion without, however, any part of it being under water or impossible of easy inspection. The Board, therefore, regards this as a most opportune time to make an excursion for this purpose, and we have received unofficial assurances that we will be given every necessary facility and opportunity for a thorough examination of the work.

CANAL WORK IN AUGUST.

The grand total of Canal excavation to September 1 was 148,192,759 cubic yards, leaving to be excavated 47,130,620 cubic yards, or less than one-fourth of the entire amount for the completed canal.

The total excavation in the Central Division for the month of August, was 1,464,294 cubic yards, of which 1,442,402 cubic yards were taken from the Culebra section. This is the greatest amount of material ever removed from the Culebra section in any month of the rainy season since the commencement of the work by the United States.

HOW TO MAKE UP EMPIRICAL FORMULAS.[1]

BY ROBERT SIBLEY.

Two classes of formulas are met with in the practice of engineering—rational and empirical. The so-called rational formulas are those which can be deduced from known physical laws, while those classified under the heading of empirical, as a rule, have little or no theoretical basis back of them, but by mere "cut and try" methods are found to express with a certain degree of exactness the results obtained by actual test or design.

In the study of higher mathematics, we find many interesting deductions. One of the most interesting and practical results which has been established in this higher realm of reasoning is that relating to the expansion of any given equation into a definite series of ascending powers of the variable or unknown quantity. Thus it is shown that for certain definite conditions any variable quantity can be expanded in a series of the form

$$y = A + Bx + Cx^2 + Dx^3 + \ldots\ldots\ldots$$

Nature, in her evident endeavor to simplify her laws, seems to operate largely in the first and second powers of the variable, though occasionally it is necessary to take into account even higher powers. In a large number of cases the results of a test, or the unknown law which it is desired to express in algebraic form, approximates very closely a straight line, which is represented algebraically by the equation

$$y = A + Bx$$

Again many laws in steam engineering seem to obey the exponential law which, algebraically expressed, is of the form

$$y = Ax^B$$

and by taking logarithms of both sides of the equation, this becomes

$$\log y = \log A + B \log x$$

By comparing this with the equation above, it is seen to resemble $y = A + Bx$ in general form, the only difference being that the logarithm of the number appears instead of the number itself, and when it is remembered that actual numbers are found by taking the logarithms of experimental data, the relationship is still closer. Hence if we can find a method of picking out proper constants of A and B in the first equation, a similar process will suffice for the latter, and we shall at once be enabled to form our empirical equation. The rules we shall give, however, are perfectly general and can be easily extended to any power of the variable in terms of which we desire to express our law.

The question now arises as to how we proceed to form an empirical equation, first as to the general expression of the equation, and secondly as to how the constants are actually computed. A concrete example will best suffice to illustrate both points. In the calibration of an anemometer for the measuring of chimney gases, the following data were amassed.

It was desired to get an algebraic expression which would accurately represent this experimental data. In a word, it was desired to form an equation so that by simply substituting in this algebraic expression the number of revolutions the anemometer turned, the velocity of the outgoing gases could be at once computed.

The first thing that should be done in any problem of this nature is to plot the data, using the horizontal line for the independent variable, or in this case for the

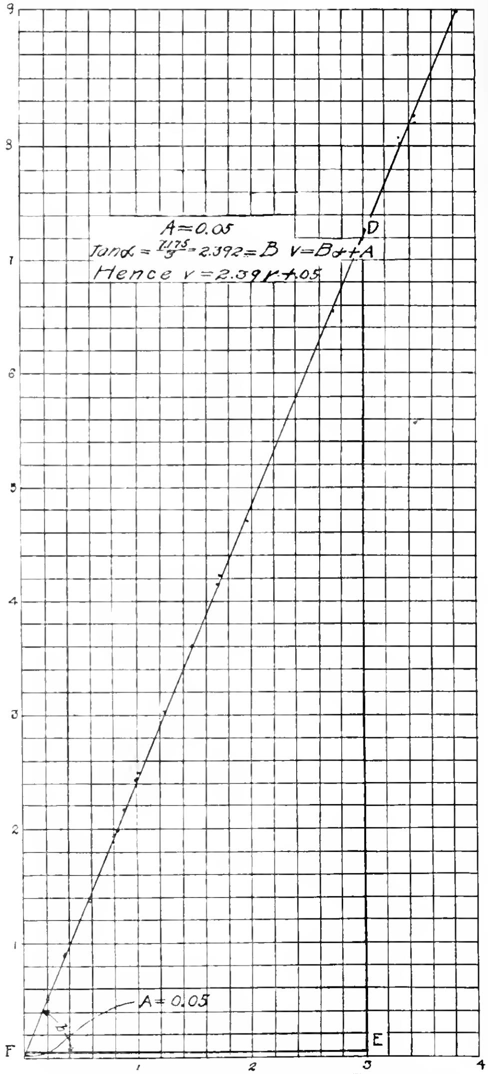


Fig. 25. Straight Line Empirical Formula.

revolutions of the anemometer, and the vertical line for the dependent variable, or for velocity in this example. Fig. 25 shows the resulting curve. At a glance we note that evidently our law is a straight line. Hence we assume

$$v = A + B r$$

In this v is the velocity in feet per sec., r is the number of revolutions per sec., and A and B are con-

[1] To be placed as an appendix in the compilation of the [illegible] lectures appearing in the columns of this Journal as A P[illegible] of Applied Thermodynamics.

stants. Looking for a moment at the diagram we can at once guess with some approximation to the truth, the values of A and B to use in our equation. It is seen, however, that the personal equation enters largely into this process, and as many different equations will be used as there are people guessing. To proceed with this method, however, I measure the distance along the vertical axis from the origin to the crossing of any line. This I find to be 0.05. From elementary analytic geometry, I know then that A has a value of 0.05 in my assumed equation. Again, the constant B is the slope of my line, which I measure by taking any point D on the straight line assumed and scale off the distance DE and FE, which I find to be 7.175 and 3, respectively, or

$$B = \frac{DE}{FE} = \frac{7.175}{3} = 2.392$$

Hence the equation of my curve is in this case,

$$v = A + B\,r = 0.05 + 2.39\,r$$

In order to arrive at the proper values of the constants with mathematical exactness, however, I must form so-called normal equations involving A and B. It is evident more than twenty different values can be gotten. As a matter of fact, the probability is that none of them will be absolutely correct. The rule set

No.	Vel. ft. per sec.	Rev. per sec.	Rough empirical equations	Formula Normal Equation for A.			Formula Normal Equation for B.		
	v	r	n a b	an	a^2	ab	bn	ba	b^2
1.	1.994	0.619	1.994 = A + 0.819B	1.994	1	0.819	1.634	0.819	0.672
2.	2.162	0.892	2.162 = A + 0.892B	2.162	1	0.892	[illegible]	0.892	0.796
3.	1.396	0.571	1.396 = A + 0.571B	1.396	1	0.571	0.797	0.571	0.326
4.	0.888	0.357	0.888 = A + 0.357B	0.888	1	0.357	0.317	0.357	0.127
5.	0.899	0.357	0.899 = A + 0.357B	0.899	1	0.357	0.321	0.357	0.128
6.	0.511	0.202	0.511 = A + 0.202B	0.511	1	0.202	0.100	0.202	0.041
7	0.622	0.211	0.622 = A + 0.211B	0.622	1	0.211	0.130	0.211	0.045
8	1.955	0.800	1.955 = A + 0.800B	1.955	1	0.800	1.564	0.800	0.640
9	3.043	1.267	3.043 = A + 1.267B	3.043	1	1.267	3.855	1.267	1.605
10	4.720	1.961	4.720 = A + 1.961B	4.720	1	1.961	9.250	1.961	3.844
11	6.508	2.702	6.508 = A + 2.702B	6.508	1	2.702	17.590	2.702	7.300
12	3.525	1.472	3.525 = A + 1.472B	3.525	1	1.472	5.196	1.472	2.165
13	7.999	3.332	7.999 = A + 3.332B	7.999	1	3.332	26.670	3.332	11.110
14	8.204	3.447	8.204 = A + 3.447B	8.204	1	3.447	[illegible]	3.447	11.880
15.	8.104	3.332	8.104 = A + 3.332B	8.104	1	3.332	27.000	3.332	11.110
16.	8.196	3.447	8.196 = A + 3.447B	8.196	1	3.447	28.270	3.447	11.880
17.	9.130	3.834	9.130 = A + 3.834B	9.130	1	3.834	[illegible]	3.834	14.710
18	9.178	3.834	9.178 = A + 3.834B	9.178	1	3.834	[illegible]	3.834	14.710
19	4.264	1.786	4.264 = A + 1.786B	4.264	1	1.786	7.615	1.786	3.186
20	4.270	1.786	4.270 = A + 1.786B	4.270	1	1.786	7.624	1.786	3.186
21	3.602	1.493	3.602 = A + 1.493B	3.602	1	1.493	5.375	1.493	[illegible]
22	4.175	1.725	4.175 = A + 1.725B	4.175	1	1.725	[illegible]	1.725	2.975
23	2.496	1.032	2.496 = A + 1.032B	2.496	1	1.032	2.577	1.032	[illegible]
24	2.412	1.000	2.412 = A + 1.000B	2.412	1	1.000	2.412	1.000	1.000
25	1.524	0.617	1.524 = A + 0.617B	1.524	1	0.617	0.940	0.617	0.381
26	1.582	0.637	1.582 = A + 0.637B	1.582	1	0.637	1.008	0.637	[illegible]
27	1.331	0.535	1.331 = A + 0.637B	1.331	1	0.535	0.714	0.535	0.289
28	1.167	0.466	1.167 = A + 0.466B	1.167	1	0.466	0.544	0.466	[illegible]
Total				105.918	28	43.914	259.336	43.914	108.015

forth will, however, pick according to the scientific methods of least squares, the most probable value for the equation we have determined upon. It makes no difference whether there are two constants to be determined or many more, the rule is the same.

In the table above appear twenty-eight equations with two unknown constants, A and B. In order to determine the most probable values of A and B, we must, as stated above, form socalled normal equations. Multiply the components of each equation by the coefficient of A in that equation, thus forming twenty-eight new equations. Add the corresponding coefficients in each equation, and thus form the socalled normal equation involving A, which is seen along the line heated, total, in the above table. Similarly, form the socalled normal equation involving B by multiplying the components of each equation by the coefficient of B in that equation, and by footing up the coefficients as shown in the above total, referred to. Thus we have now two equations, involving two unknown quantities, as follows:

$$28\,A + 43.914\,B = 105{,}918$$
$$43.914\,A + 108.015\,B = 259.336$$

Solving for A and B according to usual methods of algebra for two simultaneous equations, we have

$$A = \frac{28 \times 259.336 - 43.914 \times 105.918}{28 \times 108.015 - 43.914 \times 43.914} = 2.377$$

$$B = \frac{105.918 \times 108.015 - 259.336 \times 43.914}{28 \times 108.015 - 43.914 \times 43.914} = 0.0477$$

Hence in this case we are enabled to arrive at the most accurate equation for the calibration of our meter. The equation is the following:

$$v = 0.048 + 2.38\,r$$

By substituting in the above equation, the experimental data, it will be found to represent accurately each set of values determined in the test. It is very often the case that the first power of the variable is not accurate for the proper representation of our test. The second power will nearly always be found to represent almost all lines that are fairly even and which do not turn back on themselves when plotted—in other words such lines as are wholly convex or concave. If still closer results are desired, the third power will still more nearly correctly represent the function. In any event the method outlined in forming the normal equations is perfectly general, and will pick the most probable values for the constants involved, whether or not the equation assumed is on the whole a representative expression for the data found by experiment. The only way one can be sure that the equation does finally represent the data is to actually substitute the values in the equation so found, and it will be seen at once to what degree of accuracy the equation may be depended upon.

The logarithmic law above alluded to is assumed many times in the practice of engineering.

Simple examples involving the logarithmic law may be found in the following thermotwisters. The student is advised to try their solution. If this logarithmic law is once mastered, an excellent weapon in analysis is added to an engineer's equipment.

Thermotwisters.

1. Darcy and Bazin experimenting on the flow of water compiled the following experimental data:

No. of exp.	1	2	3	4	5
Mean velocity (v)	1.73	1.98	2.17	2.33	2.46
Hydraulic radius (r)	11.4	14.4	17.0	19.2	21.2

Assuming that the velocity of water in channels is of the form of $v = m\,r^n$, show that $v = 0.446\,r^{0.55}$ is an empirical formula for compiling the mean velocity.

2. In a steam engine it is found that after cut-off takes place the pressures and volumes during expansion of the steam have the following values:

60 lb. absolute press.	corresponds to	7.107 cu. ft.
50 " " "	" "	8.429 " "
40 " " "	" "	10.39 " "

Assuming the steam expands according to the law $p\,v^n = K$, where n and K are constants, determine their value.

SOLUTION OF THERMOTWISTERS—EIGHTH LECTURE.

1. Water is to be raised from 60° F. to 200° F. in a feed-water heater, the weight of water being 10,000 lb. per hour. Heat is supplied by steam at atmospheric pressure, 0.95 dry. Find the weight of steam condensed (a) in an open heater, (b) in a closed heater. Find the surface necessary in the latter.

(a) From feed-water formula in lecture, we find

$$W\,(x_o L_o + h_o - h_2) = w\,(h_1 - h)$$

where $x_o = .95$, $L_o = 970.4$ $h_o = 180$, $h_2 = 168$, $w = 10{,}000$, $h_1 = 168$, $h = 28$.

$$\therefore\ W = \frac{10{,}000\,(168 - 28)}{0.95 \times 970.4 + 180 - 168} = \frac{1{,}400{,}000}{933.9} = 1500.\quad \text{Ans.}$$

(b) In this case $h_2 = h_o$. Hence substituting

$$W = \frac{10{,}000\,(168 - 28)}{0.95 \times 970 + 180 - 180} = \frac{1{,}400{,}000}{921.9} = 1520.\quad \text{Ans.}$$

To compute surface necessary in (b)

$$S = \frac{W\,L_o}{180\,(t_o - t)} \text{ in which } t_o = 212 \text{ and } t = \frac{200 + 60}{2} = 130.$$

$$S = \frac{1{,}400{,}000 \times 970.4}{180\,(212 - 130)} = 921 \text{ sq. ft.}\quad \text{Ans.}$$

2. Steam 0.96 dry at 130 pounds gauge pressure delivers 3250 pounds of water per hour from an injector at a temperature of 165° F., the inlet temperature of the water being 62° F. The water is measured on the inlet side of the injector. Find the weight of steam used. The velocity of the entering water is 13 ft. per second. That of the discharge is 115 ft. per sec. Find the velocity of the steam leaving the discharge nozzle. How many boiler horsepower are required or represented in the steam necessary for the injector.

Since y = No. of lb. of water per lb. of steam, then x lb. of steam would draw in x y lb. of water, or $x\,y = 3250$, but

$$y = \frac{x_o L_o + h_o - h}{h_1 - h}$$

From tables for 130 lb. pressure (gauge) $L_o = 865.3$, $h_o = 327.1$, $h = 30$, $h_1 = 133$.

Hence substituting

$$\frac{3250}{x} = \frac{0.96 \times 865.3 + 327.1 - 30}{133 - 30} = \frac{1128.1}{103}$$

$$\therefore\ x = 3250 \times \frac{103}{1128.1} = 294.0.\quad \text{Ans.}$$

$$x\,y = 3250\ \therefore\ y = \frac{3250}{x} = \frac{3250}{294.0} = 10.93$$

$$\text{Since}\quad v_1 + y\,v = (1 + y)\,V$$

$$\therefore\ v_1 = (1 + y)\,V - y\,v = (1 + 10.93)\,115 - 10.93 \times 13 = 1514.\quad \text{Ans.}$$

Since injector requires 294.0 lb. of steam per hr., which has been heated from water at 62° F., the energy represented per hr. is

$$294.0\,[0.96 \times 865.3 + 327.1 - 30] = 333600 \text{ B.t.u. per hr.}$$

$$1 \text{ Boiler H.P.} = 970.4 \times 34.5 \text{ B.t.u. per hr.}$$

$$\therefore\ \text{H.P.} = \frac{333600}{970.4 \times 34.5} = 9.92.\quad \text{Ans.}$$

LETTER TO THE EDITOR.[1]

Editor Journal of Electricity, Power and Gas:

San Francisco, October 31, 1911.

In compliance with your request I am handing you herewith a discussion in the form of a letter to the Editor, which I have entitled, "Public Work and Engineering," and which practically covers the conversation we had the other day. I wish to impress upon you that these remarks are made "sine ira et studio," and are based on a number of occurrences I have witnessed during my eleven years' practice in this country. The remarks do not refer to any individual case, nor do they refer to any individuals connected with any specific public enterprise, and the incentive for expressing my opinion as I did during our recent conversation lies principally in the fact that I have been familiar for twenty years with the ways of carrying out public work in the old country and by force must make comparisons.

The term "public work" in this discussion is applied to any construction work which is undertaken by federal, state or municipal authority and to be paid for out of public funds.

At the present time an extraordinary amount of such work is under way in the United States, partly due to the steadily increasing tendency toward public ownership, partly due to the fact that certain work of engineering requires so large an amount of money and an organization so vast that it could hardly ever be undertaken by private capital. As belonging in the latter class I will mention the Panama Canal and the development of the United States Reclamation Service, harbor work and river regulation, state highways, and, for municipal work, water supply, sewerage, municipal street railways and light and power plants.

If anyone or any corporation can afford to avail itself of the best engineering talent it should be the government, no difference whether federal, state or municipal, and as a rule it can do so at considerably less expense than private parties or corporations, because engineers, quite frequently, have the excusable weakness to place prestige above remuneration. Without any question, public work should be of the very best and no expense spared to obtain the most satisfactory results money can procure and the state of the art can produce. This lies in the nature of conditions; public work is executed without consideration for dividends, nor is there any time limit set within which the work must have paid for itself. In other words, while individuals rarely go into an enterprise where more than ten to twenty years are required to make the originally invested capital available again for investment, and corporations borrow money for from twenty to forty years on an average, the government may easily finance a public enterprise on the basis of redeeming its bonds in not less than ninety-nine years, thus reducing the amount to be set aside annually as sinking fund for such redemption.

[1][The editor is pleased to publish the above discussion which has been furnished him in the shape it is printed, and wishes to state that this journal is not responsible for any of the opinions uttered by the writer of the letter; but an invitation to the use of our columns is always extended for discussion of fruitful topics.]

As a matter of fact, we find to-day public work designed and constructed on a much higher plane of perfection than any private work, but we do not always find the best engineering talent connected with such work. This may be partly due to the fact that the best talent is not always available at a moment's notice, or that it cannot always be readily found—many engineers of great ability are entirely too unassuming to put themselves in the limelight of publicity—or the red tape and favoritism often connected with public work frightens the talent away, sometimes even after it had been discovered and won for the work.

Enginering talent may display itself in three distinct branches and very rarely may an individual be found that is efficient in all of them. These are:

1. Planning work, which requires theoretical and practical knowledge of the particular branch of engineering specialized in and intuition for quickly finding the best solution of a new problem;

2. Designing work, which requires theoretical and practical knowledge, but as a rule to a much higher degree than in the first case, which results in a subdivision into specialists to a greater extent than for planning work

3. Execution of work, which requires much less theoretical knowledge, but more practical experience than either of the two first named branches, and besides that a high degree of experience in handling matter and men, tact and diplomacy, and last, but not least, the ability to select lieutenants successfully to create and maintain an organization and to get away from detail work.

When we come to scan over the engineering personnel connected with public work we generally find the first branch fairly well represented, the second one very poorly, if at all, and the third one better than perhaps anywhere else.

Why is it so? The question may be answered by the well-known law of inertia applied to human nature. Scanning over advertisements relating to help wanted and situations open, the word "permanent position" or even "life position" is paramount. Even the younger and youngest members of the profession seem to be anxious to get located where they can stay and "grow with the business." This is a mistaken idea which has frequently stifled the most promising talent. While it may be true that the rolling stone gathers no moss, it is not less true that the stone that once got stuck in a rut of a scarcely traveled country road may provide itself of a most venerable covering of verdure as time goes on, but had it kept on rolling it might have seen many sights and gathered many experiences, and no bumps received in that experience are too hard if only our stone does not take such jumps that it will break into worthless fragments.

Great armies in time of war depend more on their reserves than on their yeomanry, especially in case of reverses, both for rank and file and for officers. Where are the reserve officers in the government engineering army to be found when big work is calling them?

HEINRICH HOMBERGER,
Mem. Am. Soc. Civil Engs.
Mitglied Verein Deutscher Ingenieure.

COMPLIMENTARY LUNCH TO PHILIP S. DODD.

About forty prominent electrical men of San Francisco met at luncheon at the Palace Hotel on November 7 as the guests of the General Electric Co. and of the Journal of Electricity, Power & Gas. The meeting was called primarily to give a hearing to Philip S. Dodd, secretary of the Commercial Section of the National Electric Light Association.

Mr. Dodd spoke on the subject of cooperation among electrical men. After a brief introduction on the advantages of getting together, he cited a number of specific instances showing the benefits of this spirit at Cleveland, Ohio, laying particular emphasis of the results of a mutual working understanding between the central station and the contractor.

The speaker called special attention to the splendid results that have followed the publication of a peoples' electrical page in the leading newspapers of Cleveland and fourteen other cities. He showed how the same scheme could be applied at Seattle, San Francisco and Los Angeles and urged the formation of a permanent electrical club to father the idea.

In this connection he spoke of the work of the Sons of Jove and various electrical lunch clubs in generating a spirit of harmony and indicated the tremendous possibilities of even more aggressive methods.

Mr. Dodd was followed by Mr. Victor Gates of Pittsburg, who told how the electrical men of his city finally got together to boost the game to their mutual benefit. Mr. C. C. Hillis, of the Electric Appliance Co., also told of the work of the Sons of Jove and urged closer action.

John A. Britton, president of the San Francisco Gas & Electric Co., laid great stress on the necessity for cooperation between the central station and the manufacturer, the jobber and the retailer, showing how an ill-advised electrical installation brings the central station into disrepute through no fault of its own. He illustrated his theme by the immediate results of cooperation between his company and the contractors. In a few well-chosen words Mr. Britton promised to lend his assistance to Mr. Dodd's several suggestions and urged like action on the part of all others present.

Dr. Thomas Addison detailed the work that has been done by the General Electric Co. in educating the public as to the advantages of electricity and gave his strong endorsement to the proposed work of the Commercial Section of the National Electric Light Association.

T. E. Bibbins, who acted as toastmaster, closed the meeting with the suggestion that this be but the first of a long series of regular gatherings of like nature. With the hearty concurrence of all present he named November 28th as the date for the next meeting to which all electrical men are cordially invited. As a committee to arrange for speakers he appointed S. J. Lisberger, H. V. Carter and E. B. Strong. Adjournment was then taken.

WHAT EVERY ENGINEER SHOULD KNOW.

Part I.

Every engineer should know how to write a clear, forceful report; a concise, direct, one-meaning specification; and a simple, un-clouded, effective business letter. If, then, the wrong use of capitals is an actual drawback to the engineer, let us banish this curse from our daily practice.

Scores of letters violating the established rules for the use of capitals come each week into the editorial department of the Journal. Some rules are given below with examples taken from our correspondence, which, we trust, will aid engineers in correcting this defect.

I. The names of the months, the days of the week, and proper names in general should all be capitalized. Remember, however, that spring, summer, midsummer, autumn, fall, winter, and midwinter should not be capitalized; neither should north, south, east, west and their compounds (north-west, etc.), and derivations (northern, etc.), unless they designate divisions of the country.

Wrong: Many engineers travel West in Winter to hibernate in Los Angeles but by February they are so pleased with their surroundings some city in the west usually becomes their permanent abode.

Right: Many engineers travel west in winter to hibernate in Los Angeles, but by February they are so pleased with their surroundings, some city in the West usually becomes their permanent abode.

II. Titles of persons should be capitalized when used in connection with proper names. Titles of governmental officers of high rank should be capitalized, whether or not they are used with proper names. All other titles not used with proper names should not be capitalized.

Wrong: William Howard Taft was master of ceremonies during October at the ground-breaking exercises for the Panama-Pacific International Exposition to be held in San Francisco in 1915. The Postmaster at San Francisco in mailing the letters containing the joyful news was as busy as the president.

Right: William Howard Taft was master of ceremonies during October at the ground-breaking exercises for the Panama-Pacific International Exposition to be held in San Francisco in 1915. The postmaster at San Francisco in mailing the letters containing the joyful news was as busy as the President.

There seems to be a growing usage however among technical journals to put without capitals titles following the names in personal columns. Thus:

Wrong: James H. Wise, Assistant General Manager of the Pacific Gas and Electric Co. was recently at the Redondo plant of the Pacific Electric Co.

Right: James H. Wise, assistant general manager of the Pacific Gas and Electric Co., was recently at the Redondo plant of the Pacific Electric Co.

III. Capitalize club, company, society, college, high school, railroad, county, river, lake, park, street, or any other common noun, where it is made a component part of a proper name; not otherwise.

Wrong: Many engineers of note recently attended the high jinks of the Bohemian Club. The graduates of many Colleges were there and everyone enjoyed the hospitality of this famous Club.

Right: Many engineers of note recently attended the high jinks of the Bohemian Club. The graduates of many colleges were there, and every one enjoyed the hospitality of this famous club.

IV. Capitalize nouns and adjectives of language or race, such as German, English, Spanish, etc.

Wrong: The heat required to raise one pound of water from 15° F to 16° F is known as one british thermal unit or as is usually technically expressed, 1 b.t.u.

Right: The heat required to raise one pound of water from 15° F. to 16° F. is known as one British thermal unit, or, as is usually technically expressed, 1 B.t.u.

V. Capitalize the first word of a sentence. This rule applies in general to quoted sentences; but not to a quoted sentence from which words are omitted at the beginning, nor to a quoted sentence-element incorporated in an original sentence.

Right: The latent water powers of the Inland Empire have been compared to Shelly's "Arethusa," in which she is described as

" . . . . ever singing
In murmurs as soft as sleep."

VI. Do not capitalize a clause following a semicolon.

Wrong: Centrifugal pumps have two excellent characteristics; Their first cost is low; they require little skill for maintenance and operation.

Right: Centrifugal pumps have two excellent characteristics; their first cost is low; they require little skill for maintenance and operation.

Better: Centrifugal pumps have two excellent characteristics; namely, low first cost and little skill required in maintenance and operation.

CENTRAL STATION COMMERCIAL PROBLEMS.

BY A. C. McMICKEN.

One of the problems confronting commercial managers in the rapidly growing cities of the Pacific Northwest is the matter of extension of lines. The suburbs of most of our cities are growing rapidly and requests are being made continually for electric service to the more or less isolated and sparsely built districts. It is, of course, desirable to wait until these districts are well built up before making any extensions to serve them, but this is hardly possible of attainment, so persistent are the pleas for service. The problem of taking care of this business has been met in numerous ways. Some companies have resorted to a cheaper line construction than is used in the more thickly settled districts, but this method has proven unwise for the reason that before such lines have passed their useful life the rapid growth of the district has made it necessary to rebuild and reconstruct to a large extent in order to give service. A number of companies require the customer to deposit a sum equal to the cost of constructing such extensions, which sum is credited to his lighting account. The customer must consume sufficient energy in one year or less, to absorb this credit or the balance is forfeited to the company. Other companies require the customer to guarantee an income equivalent to one-half of the cost of the extension the first year, after which period the regular minimum is effective. This is done both by taking a cash deposit equivalent to one-half the cost of the extension and crediting it to the light account and by having the customer sign a contract to pay not less than one-twelfth of this amount each month as a minimum bill. Where it is possible to get several customers on the same extension, the matter is simplified somewhat by pro rating the cost of the extension. A number of other methods are used, accurate data on which was not procurable. A further discussion of this subject at this time will bring out many valuable ideas.

The difficulty of making line extensions pay in new districts where no guarantee other than the regular one dollar minimum is asked, has been more or less successfully met in several ways. The sale of electric irons and cooking devices by systematic house to house canvass being the most successful

means. Small motor installations for pumping water in districts where city service is not available, is also a factor. Numerous electric ranges have been sold in districts where there is no gas service and where long hauls make the price of other fuel high.

The introduction of the electric range presents another problem. Energy at three cents per kilowatt hour is equivalent to one dollar gas or six dollar cord wood, which makes the sale of these ranges comparatively easy. The problem is whether this class of load is desirable, particularly in the outlying residence districts where feeder capacity is none too large and regulating is harder to maintain. It is generally conceded that most of this load is off peak, yet the fact remains that some of it does overlap the peak and whether the cooking rate be three cents or five cents per kilowatt hour, is it profitable business for the central station? It is certainly impractical to connect a sixty ampere range on a long secondary and the expense of extending primaries and providing additional transfomer capacity has to be taken into consideration. The demand for these ranges is steadily increasing and these problems will have to be solved by all of us before very long. At present one of the great drawbacks to the "house electric" is a satisfactory means of heating large quantities of water by electricity at a nominal cost. There are many types of electric water heaters, none of which are without many objectionable features.

A number of the smaller central stations are still wrestling with the gasoline bugaboo. This form of illumination aside from the first cost, is very cheap and in many instances the introduction of high efficiency lamps has failed to meet the gasoline plant either in cost of operation or maintenance. Some central stations have bought up all the gasoline plants and piled them in the junk heap. Others have made free installations of high efficiency lamps and have been able to hold the customer because of the greater safety, convenience, better appearance and lack of heat and odor of the electric installation. A number of gasoline plants still remain, however, and this problem is still before us.

In some cities the gas company is well entrenched by reason of its being established long before the central station and for this reason there are many buildings and houses which have never been wired. The growth of the city away from the old business center and the erection of the modern buildings leaves a class of tenants in the old structures who usually feel that they cannot afford to wire for electricity. The property owner usually does not want to make any improvements until such time as he can remodel or rebuild the whole structure. This puts the matter of wiring up to the central station if it wants this business. In many instances the owner or tenants have been willing to pay for this wiring if allowed to do so in installments paid monthly to the central station.

The growth of the electric power business in the past few years has been tremendous. Probably the most serious problem met by the power engineer in our coast cities and towns is the oil burning isolated manufacturing plant. Fuel oil is now being purchased at from 70 cents to $1.25 per barrel and in years gone by was bought as low as 50 cents per barrel. With this fuel a number of isolated plants are producing power as low as thirty dollars per horsepower year and the majority of plants of fifty horsepower and larger do not exceed forty dollars per horsepower year for ten hour operation per day. To induce such plants to change over to electric drive at rates profitable to the central station requires some ingenuity and very careful study on the part of the power engineer. Waste fuel from saw mills and planing mills is also a serious competitor. It has been proven in a number of instances that the manufacturer is often willing to pay a little more per horsepower year for electricity providing the output of his factory can be increased by the installation of motors and the reduction of friction losses usually accomplishes this point.

The rapid adoption of small high efficiency lamps by meter residence consumers is another source of worry to the commercial manager. They have done much to reduce the income from residence business and many central stations have taken steps to control the sale of high efficiency lamps smaller than forty watts in size. Others have helped out the earnings by pushing the sale of cooking and heating devices and a few have adopted new forms of ligthing rates with the idea in mind that they are selling service rather than a commodity. The high efficiency lamp, generally speaking, has been a boon to the central station, making it possible to secure much business which could not be reached before and educating the public to the use of more light.

In our larger cities the installation of isolated plants in office buildings, hotels, laundries, etc., has to be continually fought against. The high state of perfection attained by the manufacturers of this class of machinery, together with the necessity for steam heat for at least nine months out of each year, gives the isolated plant engineer many excellent talking points. Unless the central station is in a position to sell both steam and electicity the best salesmanship and engineering ability is necessary to secure large loads of this kind. It is often possible for a modern isolated plant installed in a large hotel, for instance, to produce energy for a very small cost per kilowatt hour, due to the large amount of steam and hot water necessary in a building of this class.

This class of competition has in a number of cities driven the rates charged by the central station to a dangerously low figure, as well as causing no little dissatisfaction among customers who were not in a position to demand rates on the competitive basis of this kind. No commercial manager likes to see an isolated plant installed in his city, and the question arises, "Shall we get the business at any price or let the isolated plant go in?"

So multitudinous are central station commercial problems that volumes could be written and still not touch many phases of the subject. In order to bring out more ideas a general discussion of the foregoing at this convention and an opportunity for further problems to be presented will undoubtedly be time well spent.

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CONTENTS

Elsewhere in these columns will be found a few examples of correct and incorrect use of capital letters in technical writing.

An Old Fault

Many engineers in their written reports, specifications, or business letters so conceal their true meaning by high-sounding technical expressions, that the readers, upon whom they seek to make an impression, are left wholly in ignorance as to the real meaning of the mental commotion which they have endeavored to decipher.

Again some engineers capitalize words without regard to correct usage among English speaking people evidently thinking this will add emphasis to important points in the discussion. They have an idea that this undue capitalization in words may add capitalization to the project under consideration. Possibly they use capital letters as Dr. Samuel Johnson used ponderous words, thinking that if the pistol misses fire, the butt end may accomplish the purpose. A report or a specification, or a business letter rent with unmeaning capitals, sprinkled in at improper places is as forceful as the continued underlinings in little Mary's first love-letter to her school-boy sweetheart.

In making our written reports to our clients it is well for us to remember that the majority of modern readers, though in a sense the simple folk of yesterday, are no longer of the superstitious, easily convinced, take-it-as-you-say men of yesterday. Each point must be carefully and clearly proved; the specification must be open to but one interpretation; the business letter must be a simple expression of the ideas to be conveyed.

Vector Diagrams

The use of vector diagrams has greatly simplified the solution of the perplexing and complicated problems met with in the study of alternating current circuits. In obtaining the resultant electro-motive force impressed upon a circuit which receives its energy from two separate transformer secondaries, we are compelled to consider certain phase relationships between the two circuits and in doing so we unconsciously assign in our mental vision a definite polarity or direction to the terminals necessary in the connections. A thorough understanding of the papers of Professors Ryan and Hillebrand, found elsewhere in these columns, will greatly simplfy problems of this sort in the future. They add a new written language to alternating current expression. By means of the symbols suggested, no longer is it necessary for us to bear in mind the polarity of connections in forming vector diagrams, for by proper assumptions at the start, the correct relationships are maintained throughout the discussion.

One of the most perplexing factors in the practical demonstration of the use of vector diagrams is this

question of proper terminal connections. We are often able to compute with certainty the resulting electromotive forces and phase relations in the working out of theoretical combinations, but when it comes right down to the actual making of the connections, how frequently we are puzzled as to end to end relations! The new symbolic language actually representing on paper what each one must have formerly carried mentally in the solution of such problems will aid greatly in this practical application in the future.

At best the vector quantity is difficult of grasping even by those who have careful training in similar channels of reasoning. But to the uninitiated, or to the beginner who has had little previous mental exercise, the grasping of the idea of computations involving magnitude and direction is as difficult a mental feat as the physical performance of simultaneously patting the head with one hand and rubbing the stomach with the other.

If we have given that a river launch is capable of moving at the rate of eight miles an hour and a log is floating down with the current which travels four miles an hour, upon asking the average thinker to tell you whether the launch will be bumped harder in traveling up-stream or down-stream by collision with the log, one seldom gets the correct answer; namely, that the shock is the same in either case. In a word, this idea of polarity plays an important role in all engineering problems requiring the solution of factors involving directed magnitudes.

It is to be hoped that the new ideas presented in the papers referred to will be thoroughly mastered by the electrical fraternity and this new weapon of analysis in the future become a part of our symbolic language.

Economic Distribution Control in Los Angeles

Los Angeles presents to the engineering world and to those interested in civic control of public service corporations, an interesting spectacle. A decade ago this municipality awoke to its worldwide commercial possibilities. For years previous, local civic bodies and other organizations interested in the upbuilding of a great southern empire had recognized that a peculiar energy giving indescribable something existed in the lower western latitudes unknown to other parts of our country, which spurs men on to dreams and to deeds no one would dare elsewhere. And so it was that the dawn of the new century found this enterprising municipality, not only annexing a coast harbor sixteen miles away by means of the socalled "shoe-string" addition, but by a united boosting publicity campaign sending word of her greatness and growth to the very innermost recesses of our nation.

What was the result?

Every commercial enterprise was encouraged to enter Los Angeles. Great power companies were induced to spend millions, not only in actual power plant building but in the installation of a carefully designed net-work of distribution throughout the length and breadth of the city. Capital has continued to flow in from all sides, and a system of interurban electric lines has been built which for their size and convenience in service have become the wonder and admiration of all. The rapid growth of this close connection between city and country built up the rural districts on all sides. This rise in population of the surrounding country on the other hand so reflected its strength by causing continued prosperity and growth in the southern metropolis that the municipality awoke a few years later to find not only the domestic water supply absolutely inadequate for their dreams of empire in the distant future, but a shortage almost on the morrow staring them in the face. Situated in the heart of a country that already needs for its daily life every drop of water nature supplied, their only hope lay in the far distant Sierras. The efforts of the experts retained to solve the serious problem confronting the city were finally crowned with success by the city's undertaking the gigantic task of bringing its water supply from the Owens River project some four hundred miles away. It was early recognized that in order to meet the enormous interest charges in the investment necessary for the consummation of the project, every available source of income should be taken advantage of. A very pleasing feature of the Los Angeles aqueduct enterprise is its enormous power possibilities.

The question now arises as to the method to be employed by the municipality in effecting the distribution of this power throughout the city. The power companies operating in Los Angeles have perfected their distribution net-work at an enormous cost. The optimistic boosting spirit of the citizens of Los Angeles has reared this child of their creation after their own ideals. Economic law demands that those having the matter in hand should give the most earnest consideration to the question of the city's either taking over the present distributing systems in their entirety or maintaining a joint operation. For a powerful municipality, which has gained much of its power in the past by the aggressiveness of the capital there invested, to disregard these factors which have lent so much to their upbuilding, might almost be classed as child destruction.

A decade ago the people of Los Angeles by fireworks and much noise were inviting capital to enter their city in the way of investment in public service corporations. But now some advocate disregarding these vested interests in the consideration of the installation of a new distribution system, and, simply because the municipality may have the upper hand, deal a death blow to this gigantic investment which was encouraged on all sides a few years back.

This idea of a popular cry loudly preaching against the sins of monopoly and at the same time because of its present entrenchment advocating the biggest municipal monopoly of all without any regard for the fathering of these investments in the past, is all wrong. It savors too much of papa's lecture to little Johnnie on the evil effects of Sunday fishing, in which papa concludes by saying, "but remember papa likes fish for Sunday dinner."

PERSONALS.

George C. Arrowsmith of the Pacific Power & Light Company, was a recent Seattle visitor.

Thomas Mirk, of the firm of Hunt, Mirk & Co., is at San Diego in connection with engineering contracts.

William S. Graham, manager of the Snow Mountain Water & Power Company of Ukiah, is at San Francisco.

John S. Eastwood, the designer of the multiple arch dam, has opened offices in the Hearst Building, San Francisco.

S. K. Colby, manager of the electric railway department of Pierson Roeding & Co., is visiting the Pacific Northwest.

A. G. Jones, sales engineer with the General Electric Company's San Francisco office, is visiting the Eastern factories.

S. J. Van Ornum, city engineer of Pasadena, was an interested attendant at the recent Municipalities League Convention at Santa Barbara.

Joseph Hanna, manager of the Niles Car Company, with headquarters at Cleveland, Ohio, who is touring the Coast, has arrived at San Francisco from Portland.

A. Emory Wishon, manager of the southern division of the San Joaquin Light & Power Corporation, with headquarters at Bakersfield, has been visiting San Francisco.

J. W. Perry, general manager of the H. W. Johns-Manville Company, arrived from the East during the past week and spent several days in visiting the San Francisco branch.

O. B. Wilcox, of the New York and London firm of Bonbright & Co., who were the underwriters of the Great Western Power Company's first isue of bonds, is at San Francisco.

Samuel O. Dunn, editor of the Railway Age-Gazette, is a recent Portland visitor. Mr. Dunn expresses himself as greatly interested and surprised at the railroad activity in the Northwest.

E. J. Nally, vice-president and general manager of the Postal Telegraph Cable Company, who is making an inspection of the Pacific Coast offices, spent the past week at San Francisco.

George Cole, of the John R. Cole Company, has returned to San Francisco after spending several weeks at the various eastern factories represented on the Pacific Coast by his firm.

Samuel H. Powers and H. R. Tobey, who are connected with the firm of N. W. Halsey & Co. of New York and San Francisco, are at San Francisco conferring with Cyrus Pierce, the Pacific Coast manager.

William E. Coats, president of the Coats & Burchard Company of Chicago, public appraisers and engineers, was recently in Portland looking over this field with a view to establishing a branch office.

H. A. Russell, local sales manager for the General Electric Company, recently returned to his office at San Francisco, after visiting the company's Eastern factories and attending electrical conventions.

Dr. Thomas Addison, Pacific Coast manager of the General Electric Company, has returned to his headquarters at San Francisco after spending two weeks in visiting the Eastern factories and New York City.

Fred L. Webster, Pacific Coast manager for the Allis-Chalmers Company, has returned to his headquarters at San Francisco after a brief stay at the Seattle office, where business is excellent in the electrical lines.

H. C. Goldrick, Pacific Coast manager of the Kellogg Switchboard & Supply Company, of Chicago, has returned to his San Francisco office after a tour of northern cities, including Portland, Tacoma and Seattle.

W. B. Cline, president of the Los Angeles Gas & Electric Corporation, is now in the East on a pleasure trip. Mr. Cline expects to be gone several weeks and visit all the principal cities throughout the East and South.

F. L. Johnston, city engineer of Santa Barbara, has been appointed by the engineering section of the Municipalities League to keep tab on the progress of road expenditure and improvement work in the State during the coming year.

C. H. Stockweather, formerly an engineer for the General Electric Company, has been secured by the forest service to do some expert work in connection with the telephone systems used by the service. He is now at Missoula, Mont.

Leo. D. Haas, formerly with the California Electrical Construction Company, and now doing extension work at Martinez under the commercial department of the Great Western Power Company, visited San Francisco last Sunday.

C. F. Stamps of the Los Angeles Gas Appliance Company has returned from a trip in the East, taking in Chicago, and returning via Denver, where he attended the Gas Association meeting. He left Los Angeles again this week for Pittsburg.

A. M. Hunt has given up all engineering work at his San Francisco offices and left for a six months' European trip this week. Mr. Hunt has long contemplated this action on account of his health, and has discontinued all his consulting work.

C. E. Grunsky, the well known hydraulic expert, suggested some interesting ideas at the recent Santa Barbara Municipalities League Convention on taxation of unimproved property to meet its proportionate share of fixed charges in municipal ownership installations.

V. F. Gates of the Safety Armorito Conduit Company has spent the past week on the Pacific Coast, after attending the the Jovian convention at Denver. He was entertained at San Francisco by the electrical men and left for Los Angeles on November 7th, where he will spend several days.

T. G. Bradley, the power-house superintendent of the Siskiyou Electric Power & Light Company, has been visiting the steam and hydroelectric plants of the electric companies which transmit current to San Francisco Bay district. He inspected the Pacific Gas and Electric Company's plant at Electra during the past week.

OBITUARY.

On October 30th Mr. J. J. Ferrier's many friends and associates were shocked by learning of his death by accident. His death occurred on the afternoon of Sunday, October 29th, at his home in Fruitvale, California, the immediate cause being overexertion in physical culture exercises which he had been in the habit of taking daily. The shock to his family and friends was intensified by its unexpectedness, and the seeming irony of the tragedy, for none was more vital, hopeful and full of promise than he.

Mr. Ferrier was born in Sussex County, England, in 1883; came to America in 1903. His first work was with the Mergenthaler Linotype Comp_ny of New York; in 1905 he joined the electrification department of the New York Central and Hudson River Railroad and rose from a subordinate position to that of chief draftsman in the steam engineering branch of this work. In April, 1907, he came to San Francisco to enter the electrical engineer's office, Southern Pacific Company, taking a prominent position in the steam and mechanical engineering branches of the Oakland, Alameda and Berkeley electrification. Subsequently he was promoted to the position of office engineer and in this capacity handled a large number of details in connection with the foregoing installation. He was exceedingly able, conscientious and thorough, and

therefore a very valuable assistant in this organization. Besides being a member of the Masonic Order, Foresters and Eastern Star, he was also an Associate Member of the American Society of Civil Engineers and the American Society of Mechanical Engineers.

LOS ANGELES NEWS LETTER.

The Automobile Emergency Company have placed their contract with the Western Electric Company for 3,000 telephones and are rapidly making their installations along the county roads and throughout the city.

The Board of Public Utilities have recommended that the council grant a temporary franchise on San Pedro Street to the Pacific Electric Railway, to operate their suburban cars along that street to relieve Main Street of the congested condition. There is no doubt the council will grant this franchise immediately. The Pacific Electric Railway will complete the Van Nuys extension and cars will be running in about a week from Los Angeles to Van Nuys, via Hollywood.

M. H. French has just secured the contract for about 70 miles of over-head distribution for the Southern Sierras, in and around San Bernardino. Distribution will be made with 33,000 volt primaries. Plans and specifications have been drawn for an electrical railway between Marshfield, Oregon, and North Bend, Oregon. This company is headed by Mr. C. S. Smith of Marshfield. Southern California Edison Company has issued inquiry and specifications for approximately 1,600,000 pounds of 4/O strand, bare copper cable. This material is to be used for transmission lines between Los Angeles and Colton and for Long Beach and Newmark. Bids will be awarded this week.

At a meeting of the exhibitors of the Los Angeles Electrical Exposition it was decided to change the place of location from Fiesta Park to the Shrine Auditorium. This was done after considerable deliberation and principally because of the fact that the government objects to installing their Smithsonian models as well as their other exhibits under a tent. There is no doubt the Shrine Auditorium will lend itself more admirably to electrical decorations, as well as the other decorative features than the tent. Practically 75 per cent of the total space has been signed for and there is no doubt but what the show will be pulled off promptly on schedule. Drawing for the space was postponed from last Thursday to the coming Thursday on account of the rearrangement and we hope to settle that more definitely at that time. The spectacular features of the show are being worked up and there is no doubt but what this will be one of the most entertaining as well as instructive electrical shows that has ever been given. Prizes have been offered to the public schools for drawings and models of electrical apparatus, and Mr. J. H. Francis, superintendent of schools, is lending his assistance in making this feature of the show an attractive one.

The exhibitors who have already arranged for space at the Los Angeles Electrical Exposition are as follows: American Ironing Machine Co., American Multegraph Sales Co., Auto. Emergency Service Co., American Orr Concrete Pole, Bion J. Arnold, Bailey & Brant, Baker Elec. Vehicle Co., Burroughs Adding Machine Co., Baker Chase Elec. Co., Detroit Elec. Co., C. E. Cook Co., California Auto Co., Crocker & Wheeler, Columbus Elec. Vehicle, R. & L. Elec. Vehicle, Dictaphone Company, Southwest Sales Co., U. S. Elec. Machine Co., Duntley Vacuum Cleaner Co., Electric Mechanical Laboratories, Elec. Device Co., Elec. World, The Ohio Elec. Vehicle Co., Fairbanks, Morse Co., J. C. Farrar & Co., Federal Tel. Co., General Electric Co., Gans Bros., Gen. Appliance Mfg. Co., Holden Scenic Clock & Advertising Co., The Hughs Elec. Heating Co., Hughson & Merton, Holabird & Reynolds, Home Tel. Co., Hupp Corporation, Journal of Electricity, Power and Gas; Byron Jackson Pump Co., Kellman Elec. Mfg. Co., B. F. Kierulff Jr. & Co., L. A. Elec Vehicle Co., Luitwieler Pumping Engine Co., L. A. Brass Mfg. Co., L. A. Rubber Co., L. A. Elec. Railway, Paraffine Paint Co., Pac. Elec. Heating Co., W. B. Palmer, Pierson Roeding Co., Elec. Storage Battery Co., Pac. T. & T. Co, Perry Elec. Works, Phoenix Lighting & Fix. Co., McCrum, Howell Elec. Co., Pacific Electric Railway, The Maintenance Co., National Carbon Co., National School of Trades, National Elec. Works, W. G. Rightmire, Henry J. Rohrbach & Son, Southern California Edison Co., Stoltz Electrophone Co., Security Elec. Shop, Standard Oil Co., Standard Elec. Time Co., Southern California Supply Co., Shredded Wheat Co., Tuttle, Stevens Mfg. Co., Tuec Co., Western Elec. Co., Western Union Tel. Co., Woodill Hulse Elec. Co., J. A. Wilfreth, Western Rubber & Supply Co., Los Angeles Examiner, United States Government, Baker & Hamilton, Throop Polytechnic Institute.

ELECTRICAL CONTRACTORS' NOTES.

B. H. Bendheim, manager of the Newberry-Bendheim Electric Company, is making a three months' trip east.

Contracts for electrical work are being let for the German House Club Building on Polk and Turk streets.

H .C. Reed, manager of the electrical department of the Pacific Fire Extinguisher Company, is in Portland on business.

The contractors who obtained invitations to the get-together luncheon at the Palace last Tuesday noon, appreciated the invitations very much and felt a keen regret that more of the contractors were not there.

F. E. Cabot, president of the National Fire Protective Association, in an address before the National Electrical Contractors' Association, made the following statement: "This country wastes two hundred and fifty millions of dollars every year. But only fifty thousand dollars of that amount of fire losses is due to electrical causes." He further states that he does not think that they owe to any source outside of the insurance interests as much as they do to the electrical contractors.

Co-operation between contractors, jobbers, manufacturers and lighting companies has been preached from the rostrum of the California Contractors' Association for the past two years. The National Electrical Contractors sent out Mr. Duffield to tell us the same thing, the National Electric Association sent Mr. Dodd for a similar purpose, and when our own eminent electrical men, such as John A. Britton and Dr. Addison, tell us the same thing, we cannot help saying "I told you so. Let us all help."

TRADE NOTES.

The General Electric Company has sold to the Schwager & Nettleton Mills, Seattle, Wash., one A. T. B. 4, 1250-k.v.a., 1800 r.p.m., 480 v., horizontal, condensing Curtis steam turbine; also, one C. C. 2, 35-kw., 3000 r.p.m., horizontal, non-condensing Curtis steam turbine exciter unit.

The Pelton Water Wheel Company has closed a contract with the Federal Government of Porto Rico for use in what is known as the Carite Water Power Development, a 1000 h.p. Pelton impulse wheel which is to operate under an effective head of 750 feet at 400 r.p.m., complete with a 30-inch steel pipe line; also a 50-h.p. exciter set wheel. The Westinghouse Electric and Manufacturing Company will supply both main and exciter generators, which will be direct connected to the above wheels.

INDUSTRIAL

E. C. & M. AUTOMATIC CONTROLLERS FOR MOTOR-DRIVEN MACHINERY.

The Electric Controller and Manufacturing Company of Cleveland, Ohio, has recently placed on the market a line of automatic controllers designed for the specific purpose of giving the utmost convenience in the control of motor-driven machinery. It has been estimated that the output of many machines can be increased 20 per cent by the central grouping and convenient arrangement of all the operating levers. "Handiness of Control" is recognized as being very important in securing the utmost production from a machine, and the automatic controllers described in this article were designed to provide this "Handiness of Control" for starting, stopping, or reversing the motor and machine.

The controller consists of a small operator's switch, shown in Fig. 1, and an accelerating unit of different forms, one of which is shown in Fig. 2.

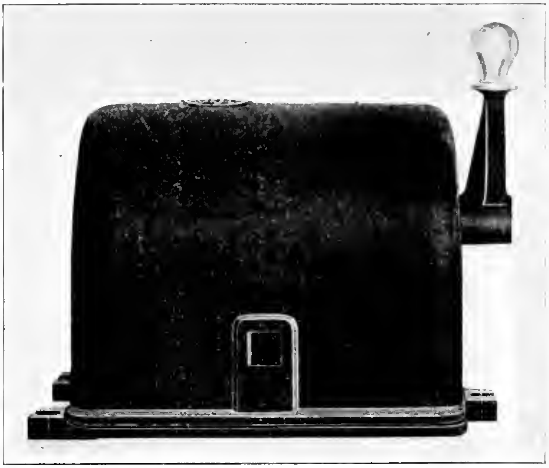

Fig. 1. Operator's Switch.

Fig. 2. Accelerating Unit

The controllers are built in three types to secure: (1st) non-reversing and dynamic braking; (2nd) reversing without dynamic braking; (3rd) reversing and dynamic braking. In each type a variety of four different forms of accelerating units are offered. These accelerating units vary in their design from a simple train of accelerating switches up to a unit having a fused service switch, a train of accelerating switches, and complete circuit-breaker features.

The accelerating unit automatically accelerates or decelerates the motor through the action of series wound accelerating switches which possess the remarkable characteristic of acting not only as switches, but as current limit relays as well. When the current in the winding of one of these switches exceeds a pre-determined value the switch locks open and cannot close until the current is reduced to the proper value.

When the operator's switch is thrown to the running position, current flows through the motor, all of the starting resistance, and the coil of the first series wound accelerating switch. As the motor accelerates the current drops, and when it reaches the correct value the first accelerating switch closes, cutting out a portion of the starting resistance. The succeeding accelerating switches operate similarly, ultimately cutting out all of the starting resistance and putting the motor across the line. By throwing the operator's switch to its original position, the motor is disconnected from the line and consequently stops. Different positions of the handle of the different types of operator's switch provide for drifting, reversing, or rapid stopping by dynamic braking.

Dynamic braking is secured by a change of connections, accomplished by the operator's switch, which first inserts all the starting resistance in series with the armature. The motor is then quickly and evenly brought to rest by automatic dynamic braking, the accelerating switches, in this case, acting as decelerating switches by cutting out, step by step, the resistance as the current, generated by the motor, decreases due to the slowing down of the motor.

The manufacturers claim the following important advantages for this automatic controller:

1st. It limits the acceleration and deceleration current at all times to a safe value.

2nd. It accelerates and decelerates the motor in the minimum, safe amount of time, and automatically varies the time of acceleration and deceleration, depending upon the load which the motor has to start and stop.

3rd. It provided the best conditions for good commutation.

4th. By limiting the current, both in starting and stopping, it limits all mechanical strains on the motor and driven machinery.

5th. It obviates the necessity of mechanical clutches on many motor-driven machine tools.

6th. It adds very materially to the safety of an installation, since in case of accident the motor may be quickly stopped.

7th. It inherently provides no-voltage protection, for if the voltage fails the switches drop open, and upon the return of voltage they automatically close in their regular method and sequence, again accelerating the motor to full speed.

FOURTEENTH ANNUAL CONVENTION AND MUNICIPAL EXHIBIT OF THE LEAGUE OF CALIFORNIA MUNICIPALITIES.

The League of California Municipalities held their fourteenth annual convention at Santa Barbara on October 23 to 28, inclusive. This meeting was by far the most uccessful, most interesting, and the most enthusiastic of any in the history of the league, and it augurs well for the future of the league. The meetings were very interesting because of the valuable papers presented, the men who represented them, and the men who took part in the discussions. The various municipalities were represented by men of influence who had the power to recommend or condemn matters of procedure in their district, and the exhibitors were represented by their principals—men of wealth, influence and reputation.

The papers presented we:e as listed in the Journal of October 28th. The exhibitors included: The Barber Asphalt Paving Company, who had a very pretty booth partly of a technical nature and equipped with tables, chairs, writing materials, stenographer and other features of hospitality which were dispensed less publicly. They were represented by Mr. Kent, Mr. Webster, Mr. Alexander, and Mr. Vaile.

The Gorham Engineering and Fire Apparatus Company had a most attractive exhibit, as did all of the following firms: Glazed Cement Sewer Pipe Company, Reinforced Concrete Pipe Company, American Glass Sand Company, Pacific Clay Products Publicity Bureau, Pacific Sewer Pipe Company, Braun Knecht-Heimann Company, Union Oil Company of California, The Gamewell Fire Alarm Telegraph Company had a complete fire alarm and police patrol system in operation, Orenstein-Arthur Koppel Company, California Corrugated Culvert Company, The Austin-Western Company, Ltd., A. L. Young Machinery Company, Neptune Meter Company, Dahlstrom Metallic Door Company, J. E. Ward & Co. had a complete Ward Atomizer in operation, West Disinfecting Company,. Inc., of New York, Pacific Corrugated Pipe Company, Ransome-Crummey Company, Federal Construction Company, City Street Improvement Company, A. Carlisle & Co., The Destructor Company.

Exhibit of Standard Oil Company.

Warren Brothers Company, who had one of the prettiest booths in the place, the main feature of which was a long row of comfortable chairs and the continual dispensing of hospitality by their representatives, Mr. Reese and the Warren Brothers themselves, who came from New York and Seattle, respectively, in order to attend this convention.

The Standard Oil Company had one of the most interesting exhibits in the place, a photograph of which is shown. A complete oil derrick with pumps and wells in full operation were exhibited exactly as they are used in the field. The Standard Oil Company represented their road oils and paving materials in an attractive manner, and took the occasion to present to the public their new catalog and recently issued technical pamphlets on the subject of paving and road oil. They were represented by J. K. Firth, E. N. Percy and C. R. Mallory.

NEW CATALOGUES.

The General Electric Company has just issued a folder—No. B-3147—describing its electric glue pots.

The October number of Common Sense, published by the Electric Controller & Manufacturing Co., of Cleveland, Ohio, is a spicy and interesting issue.

The General Electric Company has recently issued Bulletin No. 4894, which is devoted to cylinder controllers for railway service. This bulletin supersedes the company's previous bulletin on this subject.

The Archbold-Brady Co., engineers and contractors, of New York, have just issued an attractive booklet on steel transmission structures and catenary bridges. The booklet is handsomely illustrated with views of designs constructed and installed by the authors.

Bulletin No. 4886, just issued by the General Electric Company, should be of considerable interest to coal mine operators. There are 59 pages of text and illustrations devoted to the advantages of electric power in operating one mine or a group of mines, and the apparatus used in connection with the operation.

The General Electric Company describes in Bulletin No. 4885, just issued, a new meter designed for accurately measuring the power used by relatively small consumers. The meter is designed for 5 and 10 ampere circuits of 100-120 volts, two-wire, 200-240 volts, two and three-wire, and for 40, 50, 60, 125 and 133 cycle circuits.

Recognizing the need for a standard machine for keeping the commutators of railway motors grooved, the General Electric Company had designed two types of a machine for this purpose and describes both in Bulletin No. 4889, recently issued. One machine is portable and the other stationary, and both require very little space for operation.

To familiarize the public with the Curtis steam turbine generators, the General Electric Company has recently issued Bulletin No. 4883 which is devoted to the general principles of the turbine and the construction of both the turbine and the generator. The bulletin contains illustrations of turbine and generator parts, as well as complete representative installations.

The General Electric Company has issued an attractive publication composed principally of illustrations of the electrical equipment of various railways throughout the country. These illustrations comprise interiors of the power stations, both main and sub-stations, and the rolling stock of various railways. Included among these illustrations are two portable sub-stations. The number of the bulletin is 4891.

Catalogue No. 53 of the Fostoria Glass Specialty Co., Fostoria, Ohio, entitled "Iris Illuminating Glassware," lists, describes and illustrates over 300 different styles of shades and reflectors in colored and iridescent patterns for gas and electric lamps. It conforms in size of page and general conception to the same company's 100-page catalogue No. 52 on cut and etched ware, with the additional feature that each of the ten distinct motifs employed in the decorating of the "Iris" ware is realistically illustrated by a three-color cut.

Bulletin 107, just issued by the Wheeler Condenser & Engineering Co., of Carteret, N. J., is devoted to a discussion of high vacuum jet condensers. The Wheeler rectangular jet condenser, to which a large part of the bulletin is devoted, is constructed on the counter current principle, the arrangement of water trays, baffles, air outlet, exhaust steam inlet, etc., being such that the enormous volume of low pressure steam exhausted from a turbine is efficiently handled with the minimum consumption of water, and the minimum consumption of power on the part of the tail pump.

NEWS NOTES

INCORPORATION.

SACRAMENTO, CAL.—Articles of incorporation for the Sierra Electric Power Company have been filed with Secretary of State Frank Jordan. The company is capitalized at $3,000,000, of which $1000 has been subscribed by the incorporators, Charles Gross, J. E. Howes, E. A. Herman, H. G. Breed and M. S. Hamilton, all of Oakland.

OLYMPIA, WASH.—Articles of incorporation were filed at Olympia last week for a projected railroad from Portland via Vancouver to North Yakima and Ellensburg. Lawrence Harmon, a Chicago attorney, is at the head of the company, which is capitalized for $5,000,000. The other incorporators are C. C. Craig of Portland, W. P. Connaway, cashier of the Vancouver National Bank, and Elmer E. Waite of Vancouver.

SACRAMENTO, CAL.—The Sacramento Water Company, a corporation formed for the purpose of furnishing the city with a supply of mountain water brought from Salmon Falls, near Folsom, has filed articles of incorporation, giving its capital stock at $1,000,000, of which $1000 is actually subscribed. Behind the company are Francis V. Keesling, Ernest L. Brune and J. W. Cook of San Francisco; Otto Grau of Markleeville, and U. R. Grant of Alameda. Keesling is also the promoter of the projected Sacramento-Folsom electric line, which is to traverse the holdings of the Natomas Consolidated. The Natomas Consolidated controls the watershed from which the new water company seeks its supply and it is assumed that the Natomas people are back of both projects. Keesling has secured 2000 inches of water, or 30,000,000 gallons a day, at Salmon Falls, 12 miles above Folsom. His company proposes to build a storage reservoir of 50 million gallons capacity at the end of the Natoma ditch also a regulating reservoir of twelve million gallons capacity. The water will be offered wholesale to Sacramento and if a contract is closed will be piped to the city limits.

FINANCIAL.

SAN FRANCISCO, CAL.—At a special meeting of the stockholders of the Great Western Power Company Thursday afternoon the capitalization was increased from $25,000,000 to $27,500,000 in order to complete the financing of the deal by which the company recently took over the City Electric Company. This was done by the passage of a resolution by the directors of the California Electric Generating Company, a subsidiary concern, to guarantee the payment of the interest upon $1,700,000 face value of the first mortgage 5 per cent bonds of the City Electric Company. By an amendment of the articles of incorporation of the California company the dividends on the preferred stock of the company were made cumulative after January 1, 1912.

SAN FRANCISCO, CAL.—The United Railroads has issued a report of the earnings of the corporation for August and the first eight months of the calendar year. The report shows a gain in gross receipts and number of paying passengers carried, as compared with the same periods of last year. No mention is made of operating expenses in the report, or of net earnings and surplus. In August the company earned gross $673,743, an increase of $33,940 over the same month of 1910, when gross receipts were $639,803. During the month 13,471,860 passengers were carried. This is an increase of 778,800 over August of last year. For first eight months of this year 102,787,800 passengers were hauled, as against 100,265,980 for same period of 1910. This represents the large gain of 2,521,820 people carried on the cars of the local street railway combine. The gross returns for this period amounted to $5,130,390 vs. $5,013,299 for same months of last year. This means a gain in gross revenue of $126,091.

SAN FRANCISCO, CAL.—The Sierra & San Francisco Power Company which has quietly been making progress, and is said to have spent a million dollars recently in equipping steam plants in San Francisco, has now made known its readiness to enter into competition for lighting contracts in all the Bay cities. The steam plant at North Beach is said to have a capacity of 25,000 h.p., while the auxiliary plant in Bryant street turns out 3000 h.p. The hydroelectric plant on the Stanislaus River has a capacity of 48,000 h.p., and the plant at Sonora a capacity of 2500 h.p. The company is carrying on an active campaign for contracts at Modesto, Stockton and Tracy, and has recently invaded Berkeley and Oakland. The United Railroads of San Francisco takes 25,000 h.p. under a contract. Both companies are subsidiary to the United Railways Investment Company.

TRANSMISSION.

RINGOLD, WASH.—The Pacific Power & Light Company has consummated a contract with the land owners or Ringold bar for furnishing electric power for irrigation and domestic purposes. A high power line will shortly be constructed.

VALLEJO, CAL.—It has been announced on Mare Island that the work of laying the concrete foundation for the new power plant machinery will be commenced within two weeks. It is estimated that an expenditure of at least $13,000 will be necessary for the work.

TACOMA, WASH.—Chief Engineer Gronen of the Nisqually Power Plant submitted to the Commissioners figures relative to the construction of an electric tramway at the power plant at La Grande. The construction contemplates an expenditure of $18,000.

PORT TOWNSEND, WASH.—An ordinance granting to the Olympic Power Company, a corporation, the right to erect poles, string wires and maintain a transmission line for transmitting electricity from its power plant in Clallam County to the City of Port Townsend, has been passed by the City Council.

SEATTLE, WASH.—City Engineer Thomson, in reporting upon five proposed power projects for this municipality, reported favorably on two, one of them being the Lake Cushman site and the other the P. H. Hebb White river site. The former site would develop power at $93 per h. p., and the latter $89 per h. p.

LOS ANGELES, CAL.—T. C. Dobbins of Gramercy place has received the contract for labor for constructing the Sierra Power Company's overhead power system from San Bernardino to Bishop, Inyo County, at $250,000. It calls for the raising of 240 miles of steel towers 80 feet high, and placing of six alluminum steel cord cables, work to be completed within six months.

WILLOWS, CAL.—The Sacramento Valley Power Company announces that it has bought the Peoples Power Company and is coming into Glenn County as opposition to the Northern California Company, by January 1st. Six solicitors are out here making contracts for power at a rate lower than that charged by the Northern company. A war is looked for in Glenn County between the rival companies.

PASCO, WASH.—James H. Moore of Portland, of the Pacific Power & Light Company, is here, preparatory to instituting preliminary work on the construction of new power and switching stations for that company. The first unit is to aggregate $80,000 and further units are to be added from time to time, and which within a few years will ultimately represent an expenditure of $500,000. The new structures will be the center of high tension wires to surrounding points.

MODESTO, CAL.—The Western States Gas & Electric Company will immediately build a power line from Stockton to Modesto and become an active competitor of the Sierra and San Francisco Power Company for business in Modesto and Stanislaus County towns. This move is believed to be the result of the recent invasion of Stockton by the Sierra and San Francisco Company. The western representative, D. V. O'Callaghan, stated that rates will be cut, and a rate war is promised. The Sierra company recently absorbed the local interests of the Lagrange Power Company and has had the field to itself.

WALLACE, IDAHO.—The Long Valley Light & Power Company has been incorporated by Walter C. Clark, president, who is also chief electrician of the Bunker Hill & Sullivan Mining & Concentrating Company, and is capitalized at $100,000. The company will supply power and water systems to the following towns: Rosebury, Crawford, Van Wyck, McCall, Lardo and Thunder City. The Van Wyck Falls, near Crawford, on the north fork of the Payette, will be developed and will generate 4363 h.p. in low water. The improvements involved are the installation of a 500 h.p. wheel and a 2300 volt generator in a power house. The company's plan for water systems consist of separate wells and tanks for each town and automatically arranged electric pumps.

ILLUMINATION.

CORVALLIS, ORE.—Colonel McGoldrick of San Francisco has applied for a gas franchise here.

SULTAN, WASH.—No bids were received for the construction of an electric lighting plant here.

POMONA, CAL.—The property owners on South Thomas street, from First to Fifth streets are planning for the installation of street lights, similar to those on Broadway, Los Angeles.

GLENDALE, CAL.—The Board of Trustees has passed a resolution declaring its intention to order the installation of the necessary appliances for lighting certain streets with electricity.

SALEM, ORE.—J. L. Day, in charge of the cluster light installations of the Portland Railway, Light & Power Company, is in this city signing up contracts for the installation of cluster light standards.

BLAINE, WASH.—J. E. Morrison, manager of the Nooksack Valley Traction Company, appeared before the council recently asking for a new franchise granting the company running rights over certain streets within the city limits.

EUGENE, ORE.—That the city intends to install a system of gas cluster lights on the business streets has been announced by Mayor F. J. Berger. Work is to be attended to as soon as the money from the sale of the $25,000 electric lighting bonds is available.

CENTRALIA, WASH.—Machinery for the new power plant constructed by the Centralia Light & Traction Company has arrived and will be installed in the next 30 days. Power for the new plant will be furnished by the Eastern Railway & Lumber Company.

TRANSPORTATION.

STOCKTON, CAL.—The survey for the route of the Central California Traction Company's line at Compton to Lockford, has been completed.

BAKERSFIELD, CAL.—A letter from the San Joaquin Power & Light Company to City Engineer Greely states that the company is planning to double track its car lines in this city.

KALISPELL, MONT.—The Flathead Interurban Railway has awarded contracts to L. L. Davis and J. A. Roe et al. for the construction of an electric street railway here. Work has practically started.

CASHMERE, WASH.—The Wenatchee Railway & Power Company has been granted a franchise by the local City Council to operate electric cars on Cottage avenue and Division street in this city.

PASADENA, CAL.—A request for a 30-year franchise, instead of one to run for 20 years, in connection with the proposed extension of the Washington street car line, has been made by the Pacific Electric Railroad.

PASADENA, CAL.—It has been reported that the Pacific Electric Railway is prepared to begin work on the proposed extension of the Washington street line as soon as a franchise is granted by the City Council. Cars will probably be running to the city limits by the first of next year.

NEW WESTMINSTER, B. C.—This place will prepare a charter amendment for the city to reserve a sum of not less than $500,000 per annum as a sinking fund to provide for the purchase of the British Columbia electric street railway and equipment at the expiration of its franchise.

OCEAN PARK, CAL.—According to plans which are now in the hands of Vice-President Shoup, a new electric line will be built from South Eighth Street, Santa Monica, following the National Boulevard to its end, and then travel over private right of way, straight across the country to Ocean Park Heights.

EUGENE, ORE.—General Manager L. Welch of the Portland, Eugene & Eastern Railway Company, announces that Messrs. Hall and Anderson of his company are in the East endeavoring to secure sufficient funds for the construction of the P. E. & E. from Monroe to Corvallis. Construction work may start shortly.

FRESNO, CAL.—M. S. Brackett, general manager of the San Joaquin Valley Electric Railway Company, now building from Stockton to Modesto, has been in Fresno for the past two days investigating with the idea of building out to Fresno. In his visit here, Brackett paid particular attention to the country between Fresno and Madera by way of Kerman.

WALNUT CREEK, CAL.—Within two weeks the line of the Oakland & Antioch Railway will be completed to the town of Lafayette, a distance of 16 miles from the new line's terminus at Fortieth street and Shafter avenue, Oakland. The rails have been laid and the trolley wires strung to within one mile of Lafayette. A big gang of laborers is at work on the one-mile stretch and the gap will be completed within two weeks.

STOCKTON, CAL.—Negotiations which may result in the extension of the Stockton Electric Street Car Company's line into Fair Oaks are known to have been under way for some time. Since the completion of the diverting canal, effectually protecting Fair Oaks from winter overflows, property has steadily increased in value on the local market. Real estate men, realizing that Stockton's growth is to extend eastward during the next few years, have been quietly securing options on pieces of property in the Fair Oaks section.

ALPHABETICAL INDEX TO ADVERTISERS

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HIGH TENSION DIRECT CURRENT TRANSMISSION[1]

BY C. F. ELWELL.

With one system about to go into operation at a voltage nearly as high as any existing alternating current system and another proposed, wholly underground, to use a voltage higher than this, it must be said that high tension direct current transmission deserves more than passing notice. The increase of losses from corona and convection currents, especially at the higher altitudes, points to the rapid approach of the limit of alternating pressures. The limit of distance in underground work is very soon reached with alternating current. With high tension direct current no corona or convection troubles arise, and apparently any reasonable distance can be covered either overhead or underground. Present methods of generating high tension direct current have their advantages and disadvantages. To realize these both in generation and transmission it would be well to look to the existing installations. Schedule No. 1 shows at a glance the progress of the past twelve years and it is well here to note that all of this is due to the perseverance and skill of one man, Mr. Thury, to such an extent that series systems have come to be known as "Thury" systems. If one man can accomplish so much, while a great many have been working on the development of the alternating system, it is hard to conceive what will happen when a similar weight of talent turns its attention to direct current. In the matter of the design of high tension dynamos it will be seen that the figures for the new station at La Roziere show an encouraging outlook.

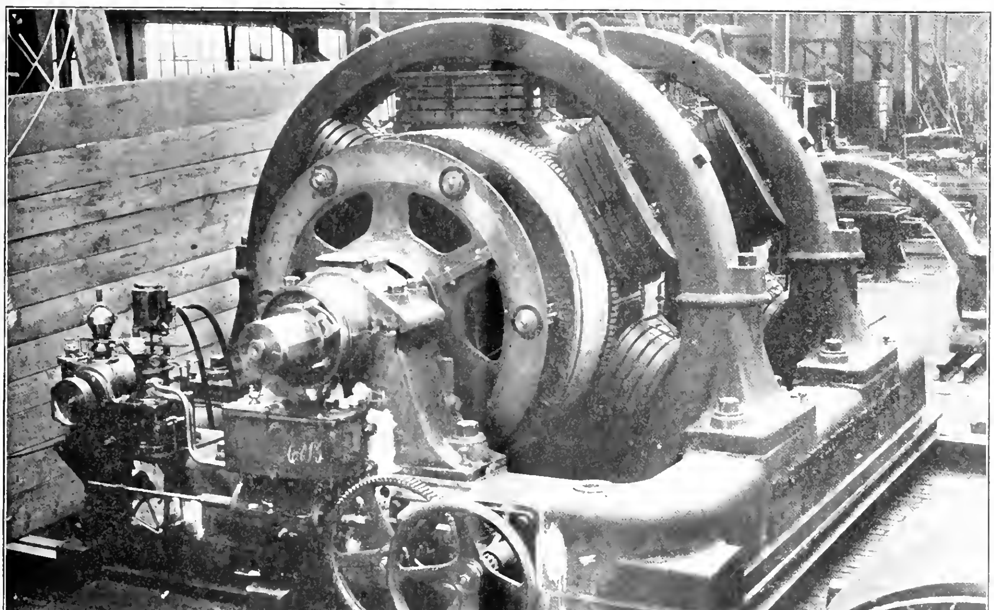


Fig. 1. A 9000 Volt Direct Current Generating Pair at La Bridoire.

[1] A paper delivered before the San Francisco Section of the American Institute of Electrical Engineers, October 28, 1911.

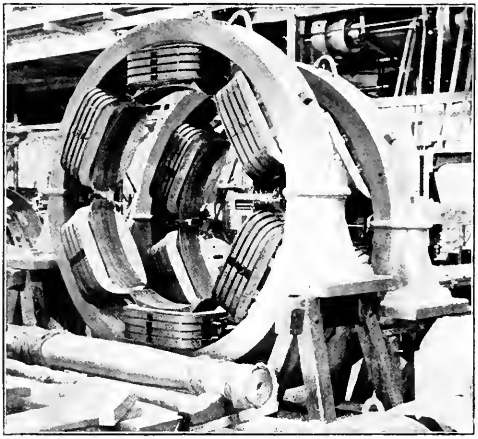
Fig. 2. A Direct Current Installation at Moutiers, Savoy, France.

The Moutiers-Lyons Transmission.

As originally planned and carried out in 1906, the generating station at Moutiers, Savoy, France, generated 75 amps. at 57,600 volts and transmitted the same to two substations in Lyons, a distance of 112 miles (180 km.) This has worked so successfully that a new station has been completed at La Bridoire which generates 150 amperes at 24,000 to 27,375 volts, and this together with another station building at La Roziere which will add from 32,000 to 35,500 volts, will be put in series with Moutiers, which, however, will be changed over to 150 amperes and the three in series will give 150 amps. at approximately 93,000 volts. The existing line and insulators will of course be changed, and additional load installed in the substations.

Generators.

Fig. 2 gives a view of the station at Moutiers. There are four sets direct connected to four turbines, but insulated from them by means of an insulating coupling. Each set consists of two double machines, separated by means of another insulating coupling. Each double machine has two armatures mounted on the same shaft.



Fif. 3. Detailed View of Generator.

One armature generates 3600 volts at a speed of 300 r.p.m., giving 14,400 volts for the set. The four sets in series give the present line voltage of 57,000. As the middle point of a pair of armatures is connected to the frame of the machine and in case of a ground on the line, there would exist approximately the whole line tension between the earth and the machine, it is very necessary that the whole be carefully insulated from earth. This is done by mounting the machines on insulators which are embedded in concrete made with lava, and the whole is covered with a layer of asphalt. The floor of the room is tiled with vitrified tile and the commutators of the machines may be touched with impunity. Further details of the generators can be seen by referring to Appendix A.

Fig. 1 shows a set as installed at La Bridoire. Each armature generates 150 amperes at from 4000 to 4562 volts giving 8000 to 9125 for the pair. At Bosel four of these will be mounted on each turbine giving 150 amperes at 16,000 to 18,250 volts. The generators at Willesden, London, England, are for 100 amperes at 5000 volts per armature.

Turbine Regulator.

In series with the line, with a shunt inserted, is a regulator which acts on all the turbines at once. The mechanical connections to the turbines can be seen in Fig. 2. This regulator works as follows: (See Fig. 5, which is a wiring diagram of the system). The small motor M drives a system of pawls continuously to and fro. The line current passing through the solenoid S_r acts on its armature which is balanced by a spring and which is attracted more or less as the current tends to increase or diminish. Its core works a lever which causes the pawls to engage a toothed wheel which works in either direction and through shafting controls the water in the turbines. Fig. 3 gives a view of the apparatus.

Switch Gear.

Each set has a pedestal (See Fig. 2) on which an ammeter and a volt-meter are mounted. On top of the pedestal two horn gap arresters in series are located and set as a tension limit for the group. The controlling switch for the set is also mounted on the standard. At the end of the machine there is a short-circuiting switch which is immediately tripped if the machine reverses its direction.

The main switchboard panel contains nothing but an ammeter voltmeter and wattmeter, with their respective shunts, and a short circuiting switch for the whole station.

Protective Apparatus.

The apparatus is protected from static by 40 horn gap lightning arresters in two sets of ten each in series and two sets in parallel. Each set is connected to earth through an electrolytic resistance to limit the discharge current.

A self induction is inserted in the main circuit between the machines and the point of connection of the lightning arresters to the line. This consists of 10 coils of iron of square cross section, mounted on insulators on the walls. See Fig. 5.

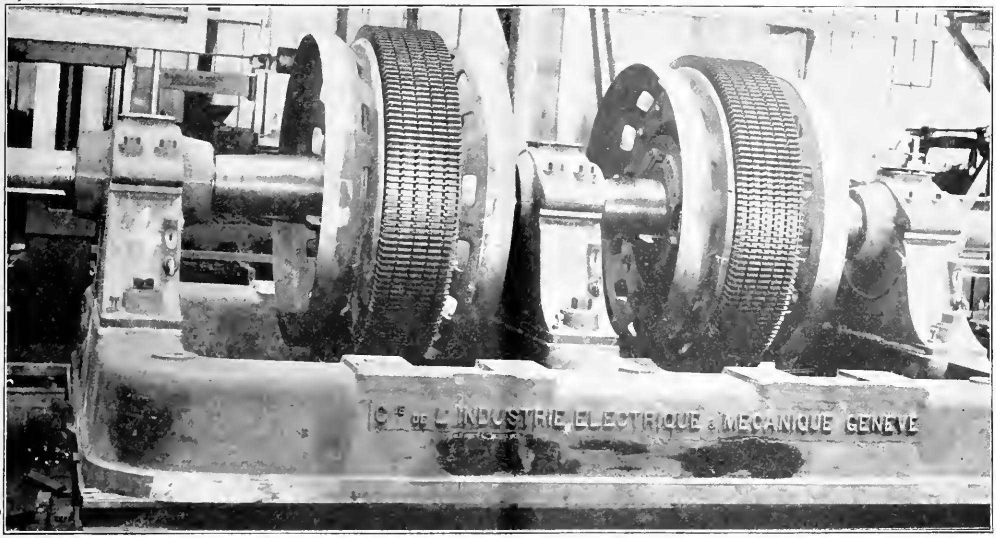


Fig. 4. 3800 Volt Direct Current Motors.

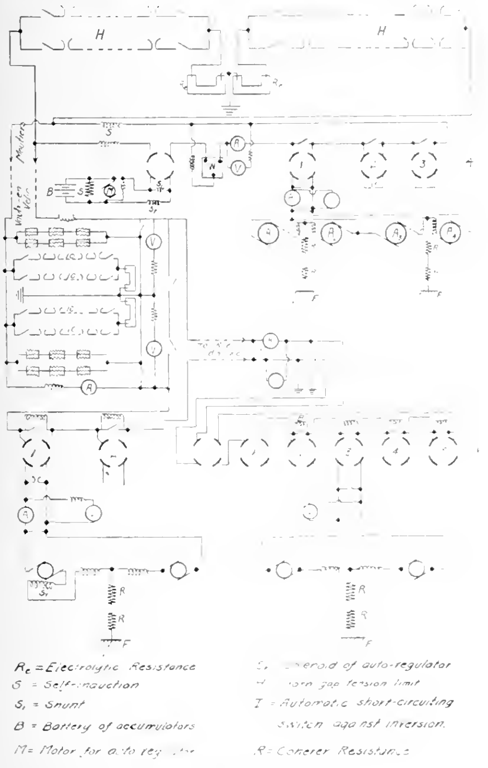


Fig. 5. Diagram of Wiring.

The Line.

The line consists of two copper conductors each 0.354 in. (9 mm.) in diameter mounted on triple petticoat insulators. From Moutiers to Sablonnieres the line is on wooden poles and thence it is on steel poles which also carry two three-phase 26,000 volt lines. These poles are 52.5 ft. (16m) high and 317 ft. (100m) apart. The resistance of the two wires is about 90 ohms and the drop about 7000 volts corresponding to a loss of 525 kw. and as this is constant the efficiency of the line is 88 per cent with full load of 4320 kw. There are 15 controls on the line all connected by telephone. The part of the line from Vaulx-en-Velin to Rue d' Alsace, a distance of 6 miles is an underground lead covered cable. These cables consist of 19 wires of 0.088 in. diam. (2.24 mm) with an insulation thickness of 0.71 in. (18 mm). The capacity is 0.12 mfds and resistance 2 ohms with an insulation resistance of 1610 megohms per mile (1000 megohms per k.m.)

Substation at Vaulx-en-Velin.

Vaulx-en-Velin is the end of the overhead line and in addition to absorbing some of the power is equipped to prevent disturbances from the line affecting the underground cable (Fig. 5). This protection consists of horn gaps, coherer resistances and Moscicki condensers. There are 40 horn gaps arranged in series parallel and having electrolytic arresters in series with each group to limit the current of discharge.

The coherer resistances consist of porcelain tubes with metal electrodes and containing a conducting powder mixed with an insulating powder. To direct current this offers a considerable resistance, but to high frequency currents the resistance is much less and this allows the line to discharge. These are connected together by gaps adjusted to stand the normal line potential.

The Moscicki condensers are arranged in four groups of eight condensers in parallel on each pole. They take care of atmospheric discharges which being high frequency pass readily through the condensers to earth.

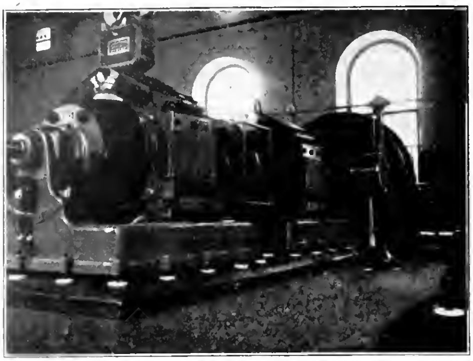


Fig. 6. Generating Station at St. Maurice.

At present the station has two groups of d.c.-a.c. reversible motor generator sets. Through transformers they can take or furnish 26,000 volts three-phase alternating current.

They consist of two 375 h.p., 3800 v. d.c motors in series on the same shaft (Fig. 4), with a 500 kw. three-phase alternator of 10,000 volts. See appendix B for characteristics of these machines. Ordinarily the motor drives the alternators but the three-phase alternators may be run as motors and the station furnish d.c. to the station at Rue d'Alsace. The speed is kept constant by means of a motor regulator which is similar in action to the turbine regulator but which is driven by means of a belt off the main shaft. This regulator adjusts the brush position to keep the speed constant as the load varies and may be seen in Fig 5.

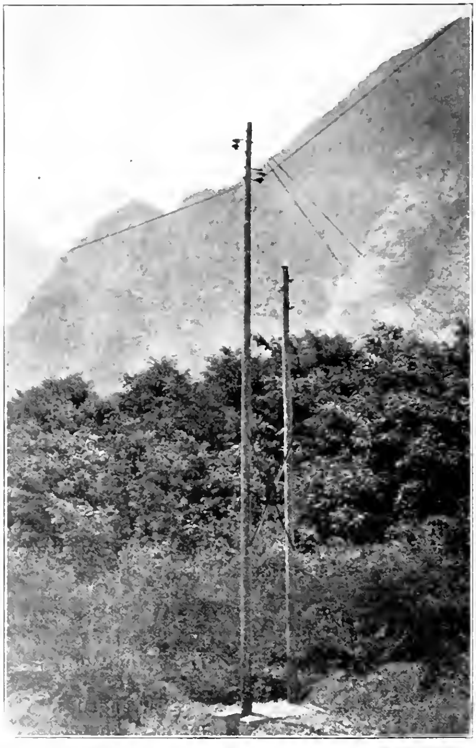


Fig. 7. Line Voltage of 27,000 Direct Current.

Each set is served by a pedestal on which is a voltmeter, disconnecting switch and tension limits. This substation has just been equipped with three more 150 ampere motors at 9125 volts, to absorb the power to be generated by La Bridoire and four similar motors will later be installed to absorb the power from the generating station which is now building at La Roziere.

Substation at Rue d' Alsace.

The cable runs to a switchboard on which are mounted an ammeter, voltmeter and short circuiting switch. There are at present 6 machines driving 500 kw. 600 v., d.c. dynamos which supply the street cars of Lyons. The series machines are exactly the same as the 3800 v. machines at Vaulx-en-Velin.

St. Maurice-Lausanne Transmission.

This transmission of 4000 kw. at 27,000 volts over a distance of 34.8 miles (56 km.) has been in successful operation for the past nine years. The generating station at St. Maurice (Fig. 6) contains six sets, each consisting of two machines generating 150 amperes at 2250 v. in series (Fig. 7) giving the line voltage of 27,000 volts. The switch gear and protective apparatus is as before described. The line consists of two leads of 37 wires of copper 0.088 in. (2.25 mm.) dia. Some success has been obtained in using the earth as a return. The drop when using copper return is 2160 volts and when using the earth is 1500 volts. Thus the efficiency is 92 per cent when using copper return and 95 per cent when using the earth. The power is used principally at Lausanne where there are eleven sets each of 400 h.p. using 150 amperes at 2100 volts. Nine of those sets have three-phase 50 cycle 3100 volt generators and two have 675 volt d.c. generators for the street car system of Lausanne. The line is also tapped at the cement works at Paudex, a suburb of Lausanne, where three 400 h.p. motors are used to drive crushers, shafting, etc., in different parts of the mill.

Chaux-De Fonds Transmission.

Though this transmission is neither large nor long it is a splendid example of what is possible using the series system. The generating station at Combe Garot has provision for nine machines of 150 amperes at 1800 volts, of which five are installed. The line is about 26 miles (42 km.) long and for part of the system two wires run on each pole while on the remainder only one, as the circuit includes several cities and factories in a ring. The conductor has a cross section of 0.43 sq. in. (150 sq. mm.), and the line loss is calculated to be 6 per cent at full load, but at present is about 10 per cent. The following stations are supplied:

Locle.

Watch Factory	140 H.P.
Bank	20 H.P.
Chocolate Factory	40 H.P.

Chaux-de Fonds.

Street car and lighting: four. . . . . .260 H.P. Motors.
two. . . . . . . .100 H.P. Motors.
Abbatoirs: one. 50 H.P. Motors.
Flour Mill: one. . . . . .140 H.P. Motors.

Eplatures.

General: five. . . . . .275 H.P. Motors.

Molliats.

General: two . . . . .150 H.P. Motors.

At Rue de l'Industrie at Chaux-de Fonds a gas engine reserve station consisting of two Deutz 250 h.p. four cycle, two cylinder horizontal engines is located, while at Eplatures a Sulzer 850 h.p. engine is installed for emergencies.

Operation.

The operation of both generating and receiving stations is quite simple. The absence of switch gear impresses one with the simplicity of the system. To put a generator on the line it is started up on short circuit until its short circuit current equals the line current. It is then switched in and automatically speeds up until it shares the load equally with other generators.

In the substations the motors are switched in series with the line and the brushes are automatically brought forward by the regulator until the motor is up to full speed. To stop a motor the brushes are brought back by hand until the voltage is zero and then the armature is short circuited.

Any overload or short circuit causes the motor to slow up and if persistent the motor pulls up and only absorbs sufficient volts to overcome its ohmic resistance. This obviates any abuse of the motors, though on the other hand prevents their use with an overload for a short interval of time.

Advantages and Disadvantages.

From the foregoing the chief advantages and disadvantages of the series system can be noted.

The chief advantages of the series system are to be found in the line, but there are also advantages of operation and installation.

1. Absence of all effects arising from impedance and capacity.

2. Strain on insulating materials is by actual experiment less than half what it is with alternating currents at ordinary frequencies. Insulator losses are small and the absence of corona and convection current loss is a favorable factor, especially for high altitude transmissions.

3. Controlling switch gear is reduced to a minimum and the operations of switching do not tend to cause surges. Voltage regulation and parallel running are eliminated. Operation is simple and does not call for highly trained attendance.

4. It is possible to transmit to any reasonable distance and very long underground lines are also possible. Transmission line construction both in copper and insulators is much cheaper than with alternating current. Wires can be spaced any distance apart and a break in the line only affects a part of it. Underground transmission is cheaper. Allowable line drop may be greater than with alternating current.

5. A number of direct current systems can readily be coupled together with absolute safety. Increase in demand at certain points does not necessitate increase in size of mains.

On the other hand must be weighed the following disadvantages, mostly of generation.

1. Difficulty of commutation of large currents when there is a large difference of potential between bars.

2. Dynamos must be insulated from earth and from prime mover, which may entail some difficulty at extremely high voltages.

3. Present designs of high voltage dynamos are not adapted for connection to high speed machines.

4. The necessity of arranging a large number of machines in series to obtain high voltages.

5. The I^2R losses in the line are constant but may be reduced for certain hours of the day by reducing the line circuit and the power of the motors.

6. Maximum torque is limited and motors cannot be overloaded. Almost all application must be by rotary transformation.

Factors Governing Selection of Direct Current.

Every case is governed by local and other conditions, but the following factors will usually be found to be the most vital. If the load is fixed and not subject to increase then the selection of direct current or alternating current will present no difficulty. The chief saving in favor of direct current will be in the line and therefore the longer the line the more likely that it will be selected. Type of prime mover and cost of current will have to be considered on account of fixed I^2R loss. The direct current loss may capitalize more money than the line saving. Size of load and distance will have their bearing on size and number of units.

Number of dynamos also depends on voltage as at present, the limit per armature seems to be about 200 amperes at 5000 volts. Four of these can be run by one prime mover to keep down the number of prime movers. It will be interesting to hear from our manufacturers what they are willing to build at the present time.

Cheapness of insulation will favor a higher pressure being used with direct current than with alternating current and consequently a lighter line. Greater voltage drop is permissible with direct current than with alternating current on account of regulation.

Usually only a portion of the load is known and the ultimate size is unknown. In planning for alternating current if the area is restricted the pressure is fixed, but for direct current the current must be fixed at a value which will suffice later, as on the line current depends the size of machines and a change of line current would mean changing all machines. By putting up insulators with a margin and commencing with a low pressure the load can be increased by installing more units in series and increasing the pressure. This means that the direct current system would not be as efficient in the beginning as when the load increased. This current may be increased by putting pairs of units in parallel. The Moutiers Lyons transmission was worked for five years as a 75 ampere line and now will be connected into a 150 ampere line, by using the generators in pairs in parallel. The voltage generated by Moutiers will be less but the addition of the new station at La Bridoire and

SCHEDULE No. 1.

	Date of Inauguration.	Line Current Amperes.	Line Pressure volts.	Total output K.W.	Distance in Miles.	Details of Machine Units. No.	Volts.	K.W.	R.P.M.	Remarks.
Ste. Acquedotto de Ferrari, Galliera, Italy	1889	45	14,000	630	37.3	18				Ring circuit
Service des eaux de Zug, Switzerland	1891	50	8,000	100	14.9	5	1600	80	320	" "
Papeteries de E.berist, Switzerland	1893	40	6,800	272	11.5	2	3400	136	...	
Communes du Val de Travers, Switzerland	1895	65	9,100	590	21.7	3	2600	170	260	Ring circuit
						1	1300	85	450	
Ste. d'Eclairage Electrique, Brescia, Italy	1895	50	10,500	525	16	3	1500	75		
						2	3000	150		
Ste. Romande d'Electricite, Switzerland	1895	50	14,000	700	11.2	4	3500	175	...	Ring
Communes de la Chaux de Fonds et du Locle Switzerland	1895	150	12,600	1890	16.1	7	1800	270	300	"
Chaux de Fonds, Reserve Plant		150	5,000	750		1	2000	300	300	"
Usines Electriques d' Eisenbourg, Ikervar-Steinamanger, Hungary						3	1000	150	180	"
	1896	65	9,000	585	40.1	6	1500	97.5	260	"
La Papelera Espanola, Renteria, Spain	1896	65	13,280	863	8.7	3	2600	169	[illegible]	
						2	2740	178		
Ste. Industrielle d'Electricite, Rieti, Italy	1896	30	12,000	360	18.6	4	3000	90	...	
V. Dunand, Batoum, Russia	1899	50	2,600	130	6.2	2	1800	65		
Usines Electriques d'Eisenbourg, Ikervar-Sopron, Hungary	1899	40	10,000	400	74.6	4	2500	100		Ring
Mines de Plomb, Linares, Spain	1900	60	10,500	630	18.6	3	3500	210		
St. Maurice-Lausanne, Switzerland	1902	150	27,000	4050	34.8	6	1500	337	300	
Moutiers-Lyon, France	1906	75	57,600	4230	112a	4	14400x	1080	300	
La Bridoire, France	1911	150	24,000	3600	b	3	8000xx	1200	428	
			27,375	1110			9125	1370		
La Roziere a Bosel, France	Building	150		4800	c	2	16000x	2400	428	
				5480	d		18250	2740		
Willesden, England	1911	100	15,000	1500	7d	3	5000	500		

x 4 armatures on each shaft. xx 2 armatures on each shaft. a. 6 miles of underground cable. b. To be cut in series with existing Moutiers-Lyons line. c. 7.5 miles from Moutiers and to work in series with Moutier and La Bridoire, giving approximately 93,000 volts. d. Underground cable. To be later part of 80 mile-120,000 volt circuit wholly underground.

La Loziere will increase the line voltage from 57,600 to 93,000.

Appendix.

A. Characteristics of Moutiers Generators.

No. of armature	4
Volts per armature	3600
Amperes	75
R.P.M.	300
Poles	6
Air Gap (7 m m)	0.3"
Diameter of armature (123.6 cm)	48.6"
Axial length of poles (30 cm)	11.8
No. of slots in armature	111
No. of coils	333
No. of commutator segments	999
Diameter of commutator (110 cm)	43.4"
Useful width of commutator (7.5 cm)	3"
No. of brush holders	6
No. of brushes per holder	2
Cross section of carbon brushes (30 x 8 mm)	1.2" x .32"

B. Characteristics of motors at Vaulx-en-Velin.

Horsepower	360
Maximum volts	3820
R.P.M.	428
Poles	4
Axial length of pole pieces (30 cm)	11.8"
No. of slots	111
No. of coils	333
No. of bars in commutator	999
Dia. of commutator (75 cm)	29.6"
Useful width of commutator (11 cm)	4.3"
No. of brush holders	4
No. of brushes per holder	3
Brushes (30 x 8 mm)	1.2 x .32

THE ENGINEER AND CITIZENSHIP.[1]

BY JAMES A. B. SCHERER.

This is an age of electricity.

"Thirty years ago," said a member of Congress to a newspaper reporter, "I walked six miles over a hot and dusty road from my country home to the county-seat to see a circus that advertised to have on exhibition a light made of electricity. There were scores of others in our neighborhood who went, not to see the circus, but to get a sight of this new marvel, the electric light.

"That was thirty years ago. Last month, on advice of my physician, I went out to a suburban sanitarium for treatment for a rheumatic trouble. At the corner I took an electric car that carried me to the suburbs. There I entered an electric automobile that whisked me a mile farther, to the sanitarium. Having arrived there, I was taken by an electric elevator to my room, where the attendant turned on the electric light and switched on the electric fan. A moment later the house physician came in. On leaving me, he said that I would be notified when to come down to the treatment room. Soon after his call an electric sign on the walls flashed the words, 'Treatment Room.'

"On going down to that apartment, I had an electric-light bath, after which the physician applied electric sponges to my aching joints. When I returned to my room the electric telephone at the head of my bed rang, and lying there, I talked to my secretary in the House office building in Washington. He had called me up to ask after my health.

"Just before day the next morning I awakened, and desiring some hot milk, summoned the night attendant by pressing an electric button. When I made known my wants the attendant retired, returning in a few moments with a small electric stove, on which he soon heated a palatable drink. Before rising that morning I had an electric massage. The nurse told me that he had just been attending a patient with a chill, and had materially relieved him by packing electric bed-warmers about him.

"During the forenoon I had a slight attack of nervousness. I was placed in an electric chair,—not the electric chair—and its gentle vibrations soon sent me off into a soothing sleep.

"During the afternoon I had occasion to communicate with a colleague on a matter that I did not care to trust to the telephone. Accordingly, I telephoned to my secretary to have the member in question call me on the telautograph punctually at a certain minute. This he did, within a quarter of a minute of the time I had set, for the clock at the sanitarium and the clocks in the House building are both connected by electric wire with the government official clock at the national observatory, and regulated to the second each day. Then I sat down and carried on a secret correspondence on an electric telautograph, by means of which the words were written by electricity at a distance of eight miles.

"When I recovered sufficiently to walk, I strolled one day up the valley to the source of all this power. It was a humble little stream that tumbled down through an iron pipe to a turbine wheel. I do not

[1] [illegible] the President of Throop Polytechnic Institute [illegible] Angeles Section, A. I. E. E.

know which excited my admiration more, the numberless uses to which I had seen electricity put, or the simplicity of this falling stream that was the moving power of it; but I do know that my emotion did not compare in intensity with the amazement that I felt thirty years before, when I first beheld that glowing glass bulb under the canvas of the old circus tent in Indiana."

I went to that same circus. I am willing to wager a quarter of an hour—"Time is money"—against any reasonable stake, that the Congressman is talking about John Robinson's "greatest show on earth," and that the inimitable clown, John Lowlow, stood in his sight, as in mine, pointing now and then in comical fashion towards a tiny intermittent spark at the top of the center-pole. Unlike the Congressman, however, I was not nearly so much interested in the electric light as I was in the circus itself, for it was the first I had ever seen. Unlike him again, my sensations at that time as awakened by my first sight of the electric lamp were not nearly equal to the interest I feel in standing before this company, comprising, as it does, the men who have made possible the hydroelectric developments that lie behind all the recent interesting experiences of the gentleman in Washington. And yet, after all, my interest arises not so much from the wonder of your professional achievements as from the fact that the training necessary to accomplish them justifies the somewhat startling thesis of this address: that upon you rests the responsibility, and with you lies the capacity, to render the largest public service possible at this time to any citizens of the republic.

I believe that a crisis confronts us. The American people are determined upon a readjustment of the relations between the public and the utility corporations, whether you like it or not; and there is grave danger lest this readjustment (which is necessary) be harmful because ill advised.

It seems to me hardly possible to deny that such determination exists; that it constitutes our leading political issue. I remember talking a few years ago with a great "captain of industry" who scouted such an idea; he said that the agitation for "progressive" policies was a mere passing fad, and soon the American people would jostle down to their usual state of sobriety. I remember also that he was distinctly opposed to Mr. Taft's candidacy because Mr. Taft was "too progressive"; yet yesterday, when President Taft was enjoying the hospitality of Los Angeles and Pasadena, representatives of his party in thirty different States gathered in Chicago to endorse a presidential candidate in comparison with whom Mr. Taft has always been the most extreme of conservatives. What did we do in California a week ago today? So intent were the people on the main question of the election that they "voted in" every one of the twenty-three amendments in spite of the fact that the authors of several of these had discovered lurking dangers, and publicly requested that their amendments be repudiated at the ballot box. Bring it nearer home. The issue is becoming local and municipal. I understand that here in Los Angeles one of the candidates for mayor is making opposition to public utility corporations the chief plank in his platform. In Pasadena this has been the main question of local politics for several years. I have no doubt whatever that the utility corporations in that and other cities have been guilty of grave error in the past; but I am also sure that among the ranks of the reformers you may also find evidences of folly, and of prejudice against a fair adjustment of the situation. The leading cause of the intense political agitation the country through is this determination of the people to secure a readjustment between the public and the utility corporations. It is this that has given rise to the adoption of the initiative, the referendum, and the recall in California. Now, while I have no fear of the proper use of these tremendous implements that we have recently taken into our hands, I am afraid of a reckless abuse of them; and it seems to me that the engineer is today the only qualified mediator between the people and the public utilities.

Just here I would like to quote from an address delivered by Mr. Justice Hughes while he was Governor of the State of New York:

"It is the function of law to define and punish wrong-doing, and not to throttle business. In the fields of industrial activity the need is that trade should be fair; that unjust discriminations and illegal allowances giving preferential access to markets should be prevented; that coercive combinations and improper practices to stifle competition should be dealt with regardless of individuals; but that honest industry, obtaining success upon its merits, denying no just opportunity to its competitors, should not be put under prohibitions which mingle the innocent and the guilty in a common condemnation. * * *

"The line of progress lies not in arbitrary action, but in securing suitable publicity and supervision, and by accurate definition of wrongs and the infliction of proper punishment. The processes of justice may be slower and more laborious; but if we desert the lines of soberness and fair play to get quick results through arbitrary interferences with trade, we shall find that such short cuts lead only to disaster.

" * * * In our progress we must seek to avoid false steps. Ours must be the rule of reason, clear-eyed, calm, patient and steadfast; defeating the conspiracies of intrigue and escaping the pitfalls of folly."

Suppose that I am a simple-minded gentleman of bucolic tastes, one of whose chief assets is a large, sleek, powerful, but sometimes rambunctious bull. Sometimes especially if I flaunt an innocent pocket handkerchief which in his eyes appears as the red rag of socialism—he is rambunctious even to the extent of chasing me out of the lot or throwing me down and prodding my pockets inside out, or even prodding in the neighborhood of the habitat of My Lord Appetite, who never stands for credit but always calls for cash in spite of the high price of food stuffs. Suppose that I escape with my life, as the American people are commonly in the habit of doing. Two courses are open to me: either I may give way to passion and blow my bull's brains out with a blunderbuss, or I may make use of my intelligence. In the latter case probably I should get together a band of strong, wise and expert gentlemen, such as these before me; drive my bull into a corner, put a small ring through his nose, and preserve him as a valuable asset within a reasonable pasturage and without danger to the public welfare.

I do not need to make my application; I see that you have already made it for yourselves.

In order that engineers may render the immense public service which the times demand, it is not sufficient that they possess merely a professional competence. Such competence may fairly be assumed. But in addition to this, the crisis requires that an engineer shall be a man of affairs; versed in business usages to the extent of being an "efficiency engineer"; but versed also in economics and the history of American political reform. The helpful engineer must be nothing less than a publicist. It is a pity that our word "politics" has fallen into such sad repute. In its origin it is a word of dignity; denoting labor for the common welfare, the common weal; that is to say, the commonwealth. An engineer must not only know his own profession but he must know politics; be in touch with the spirit of the times and able to assist in a proper direction of political reform. I wish that if this talk bore no other fruit it might at least bring to your attention Mr. Herbert Croly's book on the "Promise of American Life." Himself an engineer, he has traced in a logical and philosophic manner our political growth; pointed out the problems that confront us; and then, with the skillful hand of a master, has planned the way for constructive reform.

An engineer, then, in addition to being professionally competent must be a man of affairs and publicist; but beyond that and above all that he must, in order to do his great work, be, to an extent required of no other profession today, a man of known unimpeachable integrity. When you come to the very crux of the matter, the real obstacle in the pathway of your helpfulness to the public is the stumbling-block of doubt, or lack of confidence, on the part of the people in your incorruptibility. I do not question that the character of the average engineer is far above that of the average man in the street; my point is that you must have an extraordinary hold upon the people in order to win their confidence at this crisis, so that they will give into your hands the solution of obscure and complex problems with which you alone are competent adequately to deal.

It seems to me that the very nature of your profession should make possible the attainment of extraordinarily high standard of character. Take your vocation, if you please, in comparison with the "three learned professions," as they used to be known. The physician necessarily juggles with the credulity of his patient, and plays upon his foibles in order to relieve him of imaginary ailments; thus the physician is open to subtle temptations that may undermine absolute truthfulness of character. The lawyer, by the very nature of the case, must consider solely his client's point of view and become a special pleader, committed by duty to prejudice. Even the clergyman, in order to harmonize the entire body of scriptural teaching, is in danger of quibbling with his exegesis. But it is yours to seek the clear, cold truth, and to declare it without fear or favor. This is the chief glory of science, high priestess of our modern civilization. If you fail from the high standard of truth, it is likely to be not by virtue of these subtle temptations that beset members of other professions, but from those that are gross and palpable, amounting to the sheer corruption of bribery. When the American people attain to complete confidence in the unimpeachable integrity of the engineering profession, their Yankee common sense will lead them to turn over into your hands, as a commission, the complicated questions involved in the readjustment upon which they are determined; and then this readjustment can be wisely accomplished, with the avoidance of that havoc which comes from ignorant bungling with a delicate mechanism. I repeat the thesis with which I began; that upon you rests the responsibility, and with you lies the capacity, of rendering the largest public service possible for any class of American citizens at this time.

Speaking as one interested in the progress of education, it seems to me that there is no more important duty for an educator than to assist in the training of such engineers as those I have attempted to describe. Indeed, the more I think upon the subject of engineering education, the more strongly do I come to believe that the modern engineering college is in process of evolution into the typical twentieth century school for all sorts and conditions of men. Suppose even that a boy is going to be a preacher or a lawyer. I go so far as to say that he would make no mistake in taking our courses. He would get his Hebrew and Greek or his Blackstone after leaving here—in his professional school—with philosophy and psychology and the rest of it, which we do not profess to supply. Here he would get as much English and French, or German or Spanish, with history and civics and business law, as he could get at the old-fashioned school; and, in addition, such a working knowledge of science as would put him in touch with the spirit of his age, besides providing a means of making his living should he wish after all to quit preaching or to give up law.

I believe that as the engineer stands today as potentially the type of the most useful American citizen, so the engineering schools are developing into a true pattern for the school of tomorrow, whose chief mission must be a high citizenship, trained in the higher efficiency.

HOW TO DETERMINE THOROUGHNESS OF COMBUSTION.[1]

BY ROBERT SIBLEY.

In previous lectures we have found that when fuel is burned in combustion the flue gases are composed principally of carbon dioxide, carbon monoxide, superheated steam, oxygen and nitrogen. It is of utmost importance at times to know the proportions of these different gases as they are found in the chimney of the power plant. If now some device can be rigged up in which we can absorb the gases in definite proportions by volume in separate bottles our task is accomplished.

It has been found in the study of chemistry that a mixture containing one part by weight of caustic potash in two and one-half parts of water, will absorb carbon dioxide. Similarly by dissolving one part by weight of pyrogallic acid in two parts of hot water and three parts of caustic potash solution as described above the resulting mixture will absorb oxygen. And

[1]This paper comprises the Tenth Lecture of the "Primer of Applied Thermodynamics," which is a resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Mechanical Engineering students at the University of California.

finally by dissolving one part by weight of cuprous chloride in seven parts of hydrochloric acid, then adding two parts of copper clippings and let stand for twenty-four hours, afterwards adding three parts of water before using, a mixture is found which readily absorbs carbon monoxide gas. Now, then, if we can entrap a known volume of flue gas under a given

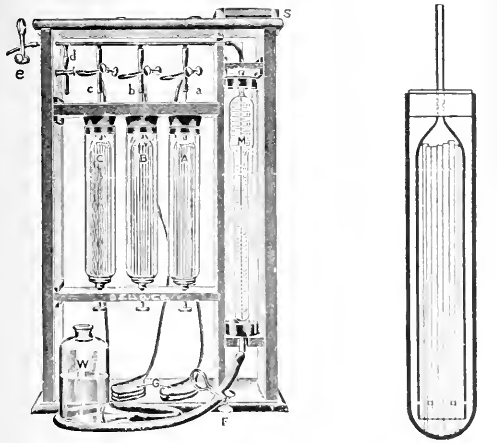


Fig. 26. Improved Orsat Apparatus

pressure and then force this gas into intimate contact with each of these solutions in turn until these particular gases are absorbed in their respective bottles and then measure the volume left under the same original pressure, we can compute at once the percentage of volume of each of the three particular component gases above mentioned in the flue gases. Repeating this process with utmost thoroughness we finally determine with exactness the carbon dioxide, carbon monoxide and oxygen in the flue gases. The superheated steam in the escaping gases is condensed into water during the measuring of the other gases.

The action of hydrogen in coal or other fuel is to increase the apparent percentage of nitrogen in the flue-gases because of the condensation of the water vapor at the time of the analysis. The nitrogen, however that accompanied the oxygen with which the hydrogen combined, maintains its gaseous form and passes into the analyzing apparatus with the other gases. Hence although by means of our apparatus we measure the carbon dioxide, carbon monoxide and oxygen only, we can compute the other constituents; namely, water and nitrogen.

The socalled Orsat apparatus is usually employed to accomplish the results above described. Fig. 26 is an illustration of this apparatus. It is convenient at times to have a permanent record of the CO_2 or carbon dioxide content in the chimney gases. Fig. 27 is a socalled combustion recorder which records the carbon dioxide content at all times. The instrument shown has been tested by the Bureau of Standards and found from a series of tryouts to have an error well within 0.75 of one per cent.

It is interesting to note that air is found by experiment to be composed of 79.09 per cent of nitrogen and 20.91 per cent oxygen by volume, and 76.85 per cent of nitrogen and 23.15 per cent oxygen by weight. Since one unit by volume of oxygen forms one unit by volume of carbon dioxide in the burning of pure carbon, the actual percentage of nitrogen in the chimney gases is not altered but should remain 79.09 per cent. On the other hand one unit by volume of oxygen forms two units by volume of carbon monoxide gas. Hence when pure carbon is the fuel, the sum of the percentages of carbon dioxide, oxygen, and one-half the carbon monoxide must be in the same ratio to the nitrogen as is oxygen in the air; namely, 20.91 to 79.09. This is a convenient check in computations. Thus an analysis of chimney gases is found to contain by volume 9.5 per cent carbon dioxide, 5.2 per cent oxygen, 10.2 per cent carbon monoxide and 75.1 per cent nitrogen. According to the law above we should have

$$\left(9.5 + 5.2 + \frac{10.2}{2}\right) : 75.1 = 20.91 : 79.09$$

By actual multiplication the relationship will be found very approximately true. In fact well within the limit of error in a careful analysis.

As fuel usually contains some hydrogen we cannot apply the above test to the chimney gas analysis unless that proportion of nitrogen which was in the air

Fig. 27. Carbon Dioxide Recorder.

that went towards consuming the hydrogen be separately accounted for. This can be done by computation involving the hydrogen content in the fuel.

It is seen that the analysis made by the Orsat apparatus is volumetric or in proportion to the volumes of the component gases. It is frequently neces-

[illegible] proportions in volumes to proportions by [illegible] In order to accomplish this result [illegible] multiply the percentages by [illegible] weight of the gas, and divide [illegible] the products. The quotient so ob[illegible] percentage by weight.

[illegible] Lecture of this series we found that [illegible] according to certain [illegible] by weight, which are multiples of the [illegible]. These can be found in any [illegible] chemistry. The molecular [illegible] gases met [illegible] flue gas analysis are [illegible] obtained from these atomic weights. Thus,

	Chemical Formula	Molecular Weight
Carbon dioxide	CO_2	$12 + 2 \times 16 = 44$
Carbon monoxide	CO	$12 + 16 = 28$
Oxygen	O_2	$2 \times 16 = 32$
Nitrogen	N_2	$2 \times 14 = 28$

[illegible] ready to compute every factor enter[illegible] analysis. The facts desired in a [illegible] the following:

1. The flue gas analysis by weight.
2. The pounds of air required per pound of fuel.
3. The pounds of air actually supplied per pound of fuel.
4. The weight flue gases per pound of fuel.
5. The ratio of the air supplied per pound of fuel to that theoretically required.
6. Heat Balance.

Let us take for example data from an oil-burning test with a Hohenstein marine water-tube boiler made with California oil by the U. S. Naval "Liquid Fuel" Board. The analysis by weight of the oil fuel was as follows: carbon, 81.52 per cent; hydrogen, 11.01 per cent; sulphur, 0.55 per cent; oxygen, 6.92 per cent. The analysis of the chimney gases by means of an Orsat apparatus was by volume as follows: carbon dioxide, 8.[illegible]; oxygen, 11.0; carbon monoxide, 1.1; nitrogen, 7[illegible]. The temperature of the boiler room was [illegible] F., the temperature of the steam for atomization [illegible] that of the escaping chimney gases [illegible]. The equivalent evaporation from and at 212 [illegible] water per lb. of fuel oil.

1. [illegible] analysis by weight. Applying [illegible] we have:

$$[illegible] = 8.6 \times 44 = 378.2, \quad \frac{378.2}{2981} = 12.70$$

$$[illegible] = 11.0 \times 32 = 352.0, \quad \frac{352}{2981} = 11.82$$

$$[illegible] = 1.1 \times 28 = 30.8, \quad \frac{30.8}{2981} = 1.03$$

$$[illegible] = 79.3 \times 28 = 2220.0, \quad \frac{2220}{2981} = 74.50$$

$$2981.0 \qquad 100.00$$

[illegible] per pound of fuel. [illegible] series of lectures, we [illegible] for perfect com[illegible]

[illegible] 32 S / 8 [illegible]

Hence substituting from the analysis of the fuel given above we have

$$11.52 \times 0.8152 + 34.56\,(0.1101 - \frac{0.0692}{8}) + 4.32 \times 0.0055 = 12.92$$

3. The pounds of air actually supplied per pound of fuel. There are a number of different ways of arriving at this result. The more accurately the data is compiled both in the analysis of the fuel as well as in that of the flue gases, the more nearly will the results [illegible] by the different methods.

$$\text{Air actually supplied per lb. of fuel} = 3.032\left(\frac{N}{CO_2 + CO}\right) C \quad \ldots (1)$$

$$\text{Also,} \qquad = 11.52 \times \frac{CO_2 + \frac{1}{2}CO + O}{CO_2 + CO} \times C + 34.56\,H \quad (2)$$

A more accurate formula, however, is derived in the following:

Let a = percentage by volume of CO_2
b = " " " " O_2
c = " " " " CO
d = " " " " N

As shown above we can convert these percentages at once into percentages by weight. Let us take x units by weight of the flue gas and at once the percentages by weight become

$$CO_2 = \frac{44a}{x} \qquad CO = \frac{28c}{x}$$

$$O_2 = \frac{32b}{x} \qquad N_2 = \frac{28d}{x}$$

and the following equations may be written at once:
Weight of carbon burned to CO_2 in x units by weight of gas

$$\frac{12}{44} \times 44a = 12a$$

Weight of carbon burned to CO in x units by weight of gas

$$\frac{12}{28} \times 28c = 12c$$

Total weight of carbon burned in x units by weight of gas
$$= 12\,(a + c)$$
Total weight of carbon burned per unit by weight of gas
$$= \frac{12\,(a + c)}{x}$$

Total weight of gas generated per lb. of carbon

$$= \frac{x}{12\,(a + c)}$$

The constituents of this last weight are as follows:
Weight of CO_2 per lb. of carbon burned

$$= w = \frac{44ax}{12x\,(a + c)} = \frac{44a}{12\,(a + c)}\ \text{lbs.}$$

$$\text{Weight of } O_2 \text{ per lb. of carbon burned} = w_2 = \frac{32b}{12\,(a + c)}\ \text{lbs.}$$

$$\text{Weight of } CO \text{ per lb. of carbon burned} = w_3 = \frac{28c}{12\,(a + c)}\ \text{lbs.}$$

$$\text{Weight of } N_2 \text{ per lb. of carbon burned} = w_4 = \frac{28d}{12\,(a + c)}\ \text{lbs.}$$

Total weight of gases w_g per lb. of fuel burned, if there proportions of carbon by weight in fuel is

$$w_g = \frac{C\,(44a + 32b + 28c + 28d)}{12\,(a + c)}\ \text{lbs.}$$

$$= \frac{C\,(11a + 8b + 7c + 7d)}{(3a + 3c)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Substituting in the three different formulas we derive results as shown.

$$3.032\left(\frac{N}{CO_2 + CO}\right) \times C = 3.032\left(\frac{79.3}{8.6 + 1.1}\right) \times .8152 = 20.22 \quad (1)$$

$$11.52 \times \frac{CO_2 \times \frac{1}{2}CO + O}{CO_2 + CO} \times C + 34.56\,H = 11.52 \times \frac{8.6 + 0.55 + 11}{8.6 + 1.1}$$
$$\times .8152 + 36.56 \times .1101 = 23.54 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\frac{C(11a+8b+7c+7d)}{(3a+3c)} = \frac{.8152(11 \times 8.6 + 8 \times 11 + 7 \times 1.1 + 7 \times 79.3)}{3 \times 8.6 + 3 \times 1.1}$$
$$= 25.6 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

4. The weight of flue gases per pound of fuel. Since we have computed in 3 the pounds of air supplied per pound of fuel evidently if we add to this weight (1—A), where A is the proportion of ash per pound of fuel we have at once the weight of flue gases per pound of fuel. Taking the result obtained from the accurate formula 3 in the above, we have for our illustrative example

Weight of flue gases per pound of fuel = 25.6 + 1 = 26.6

5. The ratio of the air supplied per pound of fuel to that theoretically required. The nitrogen in the flue-gas represents the nitrogen content in the whole amount of air supplied since as we have previously seen, nitrogen is an inactive substance and does not enter into combination in flue gases. The free oxygen which is shown in the analysis indicates an oversupply. Now each unit volume of oxygen is accompanied in air by 3.782 volumes of nitrogen. Hence the actual quantity of air necessary for perfect combustion is proportional to N − 3.782 O. The ratio of air supplied to air theoretically required is, therefore

$$\frac{N}{N - 3.782\,O}$$

$$= \frac{79.3}{79.3 - 3.782 \times [illegible]} = [illegible]$$

As a check on the above result let us apply the ratio of results computed in 3 and 2.

$$\text{ratio} = \frac{25.6}{12.92} = 2.[illegible]$$

which is practically identical. An error is liable to creep in the analysis of the fuel, the [illegible] or in both, consequently great care must be observed if true and concordant results are desired.

6. The heat balance—

(a) The heat lost in the flue gases. In our study of economizers we have previously found on page 267, that the heat lost in the flue-gases per pound of fuel is 0.24 W (T — t), in which W is the weight of gases formed per pound of fuel, 0.24 the specific heat, T the outgoing temperature of the gases and t the entering temperature. Hence substituting our value for W obtained in 4, we have

$0.24\,W\,(T - t) = 0.24 \times 25.6\,(535 - 98) = 2683$ B.t.u.

Substituting in Dulong's formula derived on page 250, I find the total heat value of the fuel to be

$$14{,}600\,C + 62{,}000\left(H - \frac{O}{8}\right) + 4000\,S$$

$$= 14{,}600 \times .8152 + 62{,}000\left(.1101 - \frac{.0692}{8}\right) + 4000 \times .0055$$

$= 18{,}202$ B.t.u.

Hence percentage of heat loss in flue gases

$$= \frac{2683}{18202} = 14.7$$

(b) Loss due to moisture formed by burning of hydrogen. On page 250 we have the following formula for losses of this nature:

Heat loss in moisture per lb. of fuel $= (9\,H + W)\,[212.9 - t + 970.4 + 0.48\,(t_1 - 212)]$

Since our analysis shows no water present as such in fuel W = O. Hence, substituting, we have

$9 \times .1101\,[212.9 - 98 + 970.4 + 0.48\,(535 - 212)] = 1326$ B.t.u.

Hence percentage heat lost in moisture

$$= \frac{1326}{18202} = 7.3\%$$

(c) Loss due to incomplete combustion of carbon. Since on page 329, we find that 14,600 B.t.u. should be given out in perfect combustion, we have a definite loss when carbon monoxide is formed as only 4450 B.t.u. are given out per pound. Hence such a loss is evidently computed by the formula,

$$C \times \frac{10{,}150\,CO}{CO_2 + CO}$$

$$.8152 \times \frac{10{,}150 \times 1.1}{8.6 + 1.1} = 938 \text{ B.t.u.}$$

Hence percentage heat lost in incomplete combustion

$$= \frac{938}{18202} = 5.2$$

(d) Loss due to superheated steam used in spraying oil is

$$0.48\,W_s\,(T - t)$$

in which W_s is the lbs. of steam used in atomizing per [illegible], T the temperature of out-going gases [illegible] t the temperature of the steam used in atomization and K is the specific heat of superheated steam for the range. Substituting

$0.48\,W_s\,(T - t) = 0.48 \times 0.779\,(535 - 352) = 67.5$ B.t.u.

Hence percentage heat lost in superheated steam of atomization

$$\frac{67.5}{18202} = 0.4$$

(e) Stray losses. Under this column is listed all other losses, such as radiation, air drafts, etc. This is computed by adding all the entire losses together with the heat absorbed by the boiler and subtracting this total from the total calorific value of the fuel. In performing this operation, we find that in this case the total stray loss is 1452.5 B.t.u. Hence stray loss

$$= \frac{1452.5}{18202} = 7.9\%$$

(f) Heat absorbed by boiler. This is computed by taking into account the total [illegible] consumed in the [illegible] of [illegible] formed per pound of fuel consumed as illustrated in [illegible] 332. In our example here given, we have total heat absorbed by the boiler

$12.10 \times 970.4 = 11735$ B.t.u. per lb. of oil fuel.

Hence boiler efficiency

$$= \frac{11735}{18202} \, 64.5\%$$

Thermotwisters.

1. In a government test on a marine boiler made with California oil the following data were taken. The analysis by weight of the oil fuel was as follows: Carbon 81.52%; hydrogen 11.01%; sulphur 0.55%; oxygen 6.92%. The analysis of the chimney gases by means of an Orsat apparatus was by volume as follows: Carbon dioxide 6.6%; oxygen 12.6%; carbon monoxide 0.4%; nitrogen 80.4%. The temperature of the boiler room was 96° F., the temperature escaping chimney gases 743° F. and the temperature of the atomizing steam 378° F. The equivalent evaporation from and at 212° F. was 11.19 lb. of water per lb. of fuel oil. Determine the heat balance for the test.

SOLUTION OF THERMOTWISTERS—NINTH LECTURE.

1. A stack is 125 ft. high. The flue gases have a temperature of 475° F., and the outside air is at 60° F., atmospheric pressure being 14.7 lb. per sq. in. How many inches of water will the draft gauge read?

On page 397, I find the following formula for draft in inches of water:

$$D = 0.52\, H \cdot p \left[\frac{1}{T_1} - \frac{1}{\left(\frac{n}{n+1}\right) T_2} \right]$$

where $H = 125$, $p = 14.7$, $T_1 = 459.4 + 60$, $T_2 = 459.4 + 475$, assume $n = 25$.

$$\therefore D = 0.52 \times 125 \times 14.7 \left[\frac{1}{519.4} - \frac{1}{\frac{25}{26}(934.4)} \right]$$

$$= 956\,[0.001925 - 0.001113] = 0.78 \text{ ins. Ans.}$$

2. It is desired to design a stack to burn anthracite buckwheat coal to accommodate 2000 boiler horsepower. What are the proper dimensions at sea-level?

In order to apply Kent's tables given on page 398, it is necessary to reduce 2000 boiler horsepower to the horsepower assumed by Kent.

1 boiler horsepower is equivalent to $34.5 \times 970.4 = 33{,}500$ B.t.u. per hr.

Assuming 1 lb. of coal to have a calorific value of 14,000 B.t.u., 5 lb. will have $5 \times 14{,}000 = 70{,}000$. Hence it is evident that a stack designed from Kent's horsepower assumption will be ample even though our boilers operate under 50% efficiency.

I find on page 398 that the proper height for a stack to burn anthracite buckwheat coal is 150 ft. Hence looking in the table I find that the effective area for 2130 horsepower is 52.23 sq. ft., requiring a total area of 56.75 sq. ft. or a diameter of 102 inches. An equivalent square chimney would be 91 inches. Ans.

PACIFIC COAST GAS ASSOCIATION.

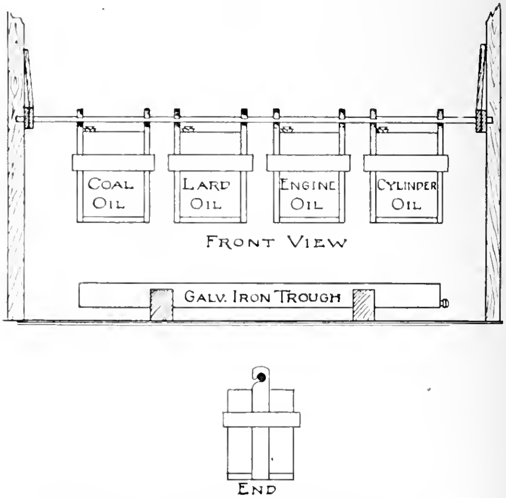
The recently adopted constitution and by-laws of the Pacific Coast Gas Association have appeared recently in printed form and are being distributed to the members of the association. The paper of C. L. Cory on Rates for Gas Service is also being distributed in printed form, according to the desires expressed at the recent convention. The wrinkles reported at the last convention appear in the following pages.

WRINKLE NO. 1.

DEVICE FOR HANDLING LUBRICATING OILS IN SMALL GAS WORKS.

BY F. H. HESS.

Illustrated below is a sketch describing a simple device for handling lubricating oils in a small gas works. It is made by making six-piece crates for ordinary five-gallon square cans and extending the side



Device for Handling Lubricating Oils in Small Gas Works.

braces above the cans sufficiently to allow hooks for suspension on a gas pipe shaft. This shaft may be supported by simple braces from the studs of the building. A galvanized iron trough on the floor is a good plan for catching all the oil spilled.

WRINKLE NO. 2.

SPLIT T-BOLTS FOR HOLDER PATCHES.

BY D. J. YOUNG.

Some time ago it became necessary to patch two large holes in a 300,000 ft. holder which was in regular use. The writer has had some experience with T-bolts for this purpose, but on account of the size of the patch we tried to get something better, and finally devised a split T-bolt, which is shown in the accompanying sketches. On account of being unable to purchase this type of bolt we were compelled to make them in order to do a satisfactory job. These were made of half-inch round brass rods bent and threaded as shown in the sketch.

One great advantage in the use of this bolt over the ordinary T-bolt is the fact that the hole through which it is placed in the holder sheet is but very little larger than the diameter of the bolt, and the work can be done with practically no inconvenience from escaping gas.

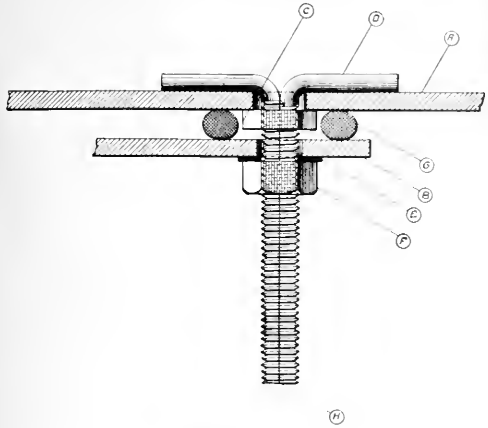


Fig. 1. Split T-Bolt in Place

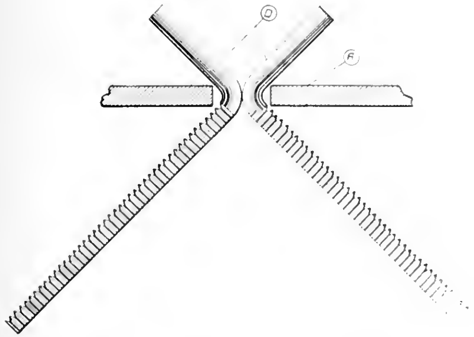


Fig. 2. Split T-Bolt Drawn Apart

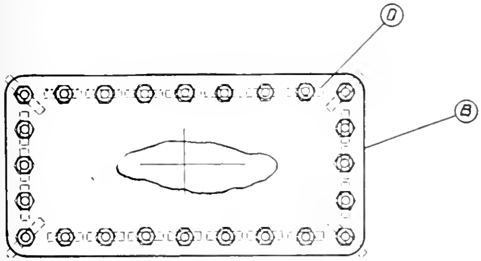


Fig. 3. Bolt Location

It might be interesting to know that we temporarily closed the large hole by the use of surgeons' plaster and soap, using the surgeons' plaster to hold the soap in place, and it worked very well as a temporary patch.

Explanation of Sketch.

Figures 1 and 2:

A—Sheet of holder.

B—Patch.

C—Lock-nut to hold bolt in place, until all bolts are set.

D—Split bolt.

E—Grummet.

F—Nut which holds patch in place.

G—Rope gasket.

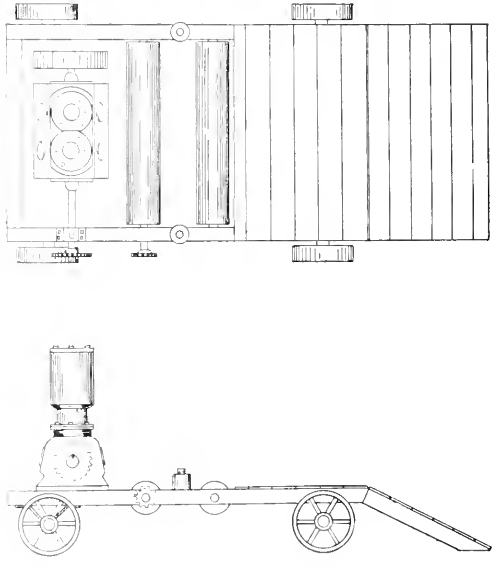
Figure 3 shows the location of the bolts, giving practically a reinforcing ring inside of the patch. The size of the patch that we applied was 48 inches square; is perfectly gas tight and gives no trouble whatever.

WRINKLE NO. 3.

A TREADMILL FOR AUTOMOBILES.

BY WALLACE H. FOSTER.

The device illustrated was suggested from experiments in constructing a compressor automobile for testing high pressure gas mains. In the case in mind, the compressor was mounted on the frame of an old automobile, power being transmitted to the compressor by friction pulleys which were driven by contact with the rear tires after the hind end of the car had been jacked up to clear wheels from the ground.


A Treadmill for Automobiles.

This operated successfully, but the automobile could be used for nothing but testing gas mains. The device illustrated can be used with any automobile and the car is still available for other uses.

A circulating water tank should also be provided on the treadmill and this by very simple hose connections could be used to cool the auto engine as well as the compressor.

WRINKLE NO. 4.

AUTOMOBILE DRIP WAGON.

BY W. R. MORGAN.

The illustration shown is an automobile drip wagon used in the street main department of the San Francisco Gas & Electric Company at San Francisco.

[illegible]

[illegible]

WRINKLE NO. [illegible]

TEST FOR NAPHTHALENE ($C_{10}H_8$) IN ILLUMINATING GAS

[illegible]

Apparatus Required

[illegible]

The Solutions Required

[illegible]

Qualitative Test.

[illegible] of gas [illegible] through 2 [illegible] containing 50 c.c. each of the picric [illegible]. The formation of a [illegible] white precipitate [illegible] naphthalene Picrate ($C_{10}H_8C_6H_2$ [illegible] O_7) in [illegible] denotes the presence of naphthalene. If no precipitate appears the gas is practically free from naphthalene.

Quantative Test.

Place 100 c.c. of the Standard Picric Acid Solution [illegible] 4 [illegible] bottles (25 c.c. in each) adding 50 c.c. distilled water to each bottle.

[illegible] as little rubber tubing as possible, join the 4 bottles [illegible]. Connect the outlet of the last [illegible] the inlet of the [illegible]. Pass about 5 [illegible] of gas through the apparatus at the rate of 1 [illegible] per [illegible] noting [illegible] the temperature [illegible].

[illegible] shut off the gas, [illegible] and rinse the contents [illegible] flask with a little distilled water [illegible].

[illegible] stopper containing a [illegible] on the outer end [illegible] rubber tubing and pinch cock. [illegible] and aspirate contents of [illegible] to remove any air, gas or [illegible] which may be present.

[illegible] place flask in water bath, [illegible] disappears. (N. B.—[illegible] tightly into flask).

[illegible] of the precipitate, allow [illegible] for 3 or 4 hours, shaking [illegible] any precipitate which [illegible].

The naphthalene [illegible] yellow-white precipitate [illegible] settle to the bottom [illegible].

[illegible] a 500 or 700 c.c. beaker, [illegible] distilled water to wash pre-[illegible] the beaker add a few [illegible]. Titrate against the Standard [illegible] which has previously been [illegible] the point at which the [illegible] turns from yellow-brown to [illegible] adding the Standard Caustic Soda Solution, [illegible] the contents of the beaker with [illegible].

[illegible] of Standard Caustic Soda Solution, [illegible] 10 c.c. required to neutralize the liquid in [illegible] 1 grain of naphthalene in the gas [illegible] during the test. The number of c.c. of the [illegible] (or grains of naphthalene) [illegible] of gas passed—corrected to [illegible] 30 [illegible] —and multiplied by 100 will [illegible] grains of naphthalene per 100 cu. ft. of gas.

Example.

[illegible] placed in 4 bottles as [illegible].

4.5 [illegible] of gas (corrected to 60 and 30) were [illegible].

[illegible] of caustic soda sol. were required to neutralize [illegible] filtrate and washings (contents of beaker).

[illegible] 10.0 c.c.

— 9.3 c.c.

4.5 c.f.) .7 c.c.

.155 grain per cu. ft.

100

15.5 grains of naphthalene per 100 cu. ft.

Of the various constituents of the hydrocarbon group in illuminating gas, naphthalene alone has an

affinity for picric acid, which is the basis of the foregoing test. For greatest accuracy the Picric Acid Solution should be kept as near 60° F. as possible. If unpurified gas is to be tested it is well to place a wash bottle containing 50 c.c. of 10 per cent oxalic acid between the gas supply and the first picric acid wash bottle, to remove any ammonia that may be present. This oxalic acid should be discarded when the wash bottles are disconnected.

Formulae.

The standard solutions are based on the following:

Picric Acid + Naphthalene = Naphthalene Picrate

$C_6H_3N_3O_7 + C_{10}H_8 = C_{10}H_8.C_6H_3N_3O_7$, or 22[illegible] parts of picric acid combine with 128.06 parts of naphthalene and also with 40.058 parts of sodium hydroxide (NaOH). Therefore 1.789 grams of picric acid combine with 1 grain of naphthalene and also with .3128 grains of sodium hydroxide. Reducing to grams—.115953 gram of picric acid combines with 1 gram of naphthalene, also with .020269 gram of sodium hydroxide, which is the quantity of acid and alkali required per c.c. of standard solution.

Difficulty was experienced in dissolving 115.935 grams of picric acid in a litre of alcohol or alcohol and distilled water, hence the acid solution noted in the foregoing, is reduced to 1/10th standard strength. With 20.269 grams of sodium hydroxide to 1 litre of solution and 11.593 grams of picric acid to 1 litre of solution, the following equation is deduced: 1 c.c. Standard Caustic Soda Solution = 10 c.c. Picric Acid Solution = 1 gram of Napthalene.

WRINKLE NO. 6.
MAINTENANCE OF REGULATORS.
BY W. J. DORR

We have a large number of individual high pressure regulators that have been in continuous service for years, some of which cause trouble on account of the diaphragm becoming dry and sticky. To remove all such regulators, bring them to the shop and repair them would mean considerable expense, and in order to avoid this expense we make a house to house canvass, examining all regulators and in cases where they are working hard or leaking slightly, we pour about an ounce and a half of neatsfoot oil onto the diaphragm. This fills up the pores of the leather and makes it pliable again. At the same time an inspection is made of the meters, and the consumers are interviewed to ascertain if the service is entirely satisfactory.

WRINKLE NO. 7.
A TANK REMOVAL.
BY SHERWOOD GROVER

The following is the general description of the story illustrated in the photographs.

Owing to improvement of the water front by the City of Oakland, a strip of our property 150 ft. wide was condemned for a water front street. It so happened that our 30,000 barrel oil storage tank was located on this property, and it became necessary to move the tank to a new location. The most advantageous location was chosen and new pile concrete foundation installed, and the next problem was to get the tank on new foundation, for between the old location and the new stood an immense pile of lampblack, the [illegible] greater than the tank itself. [illegible] were [illegible] of the tank. [illegible] the [illegible] contractor was very much [illegible] all the [illegible] secured the [illegible] why his figure was so much [illegible] than the rest, he

[illegible]

replied that [illegible] these other [illegible] were figuring on moving the tank around the pile of lampblack, in which event it would be necessary for them to pass over and make use of some of the construction work of the contractors who were building the sea wall for the city of Oakland, and these contractors, knowing there was no other way to move the tank around, were holding everybody up for a stiff price to get past their work. When asked what he was going to do, he replied he would jump the lampblack pile. The pictures show how this was done, and the dates on the back indicate the progress made. The last picture dated April 5th, shows the tank resting on new foundation. Before lowering the tank on foundation, a heavy coating of asphaltum was applied to the tank bottom, and the time necessary for this work was included in the time of moving the tank.

Tank Raised from Old Foundation and Resting on Frames

I might add that this tank has traveled some, for it originally came from the San Francisco company, and was located at the North Beach District. A description of the first moving of this tank across the bay was given to the members of the association at that time.

The tank was not damaged in any way during its passage over the lampblack pile.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
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Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

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PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

A Word on Good Roads

Some twenty thousand human beings travelled to Palo Alto last Saturday to witness the great intercollegiate football struggle between Leland Stanford Junior University and the University of California. The young men yelled themselves hoarse in support of the team of their choice, while their pretty sisters so soon to wield the ballot vied with each other in so bedecking themselves that if their team failed to win by force, a soft spot in the heart of the onlooker was sure to be reached in any event. Old men and staid matrons looked on and weighed the merits of the game of football in their minds in an endeavor to come to a conclusion as to whether football and an unkempt beard should be both classed together; namely, as "unnecessary roughness."

Be this as it may, no one could look upon such an inspiring sight composed of the best of California gathered from every nook and corner of the great Poppy State without doing some serious thinking. To the engineer it was an inspiration to see the orderly manner in which the crowds were handled. Especially was the long line of automobiles most interesting. It is doubtful if ever in the history of California—and citizens of California by the way possess more automobiles than any other State in the union with but one exception—were there so many automobiles gathered together in one small town. Citizens of cities a hundred to a hundred and fifty miles distant came with automobiles bedecked with flying colors. Many and varied were the opinions expressed as to the condition of the roads encountered. The expenditure of the millions appropriated for good roads by the last State legislature will be watched with added interest.

Dam Failures

The recent bridge failure near Auburn, California, in which an investment of over four hundred thousand dollars was jeopardized, brings forcibly to mind not only the question of investment to the owners, but also the risk of life and property of others in the failure of enterprises of such magnitude. Possibly to the superstitious the beginning of a name with "Au" will in the future inspire awe. For the technical press throughout the country is alive with comments on disasters to projects beginning with those two letters.

Two forceful examples of improperly designed engineering structure are the large masonry dam at Austin, Tex., which failed in 1900, and also the recent horrifying catastrophe at Austin, Pa., on September 30th last. It seems that the engineer called in for consultation when the weakness in the latter dam was first discovered, estimated a horizontal thrust of 78,031 lb. per lineal foot of dam and a vertical downward weight of 113,190 lb. per lineal foot. It is well known that the force resisting failure or sliding is equal to the product of the downward weight and coefficient of sliding friction. Exceed this amount by a trifle excess, and those who have walked forth on a frosty and icy morning in our northern latitudes can testify the acceleration with which nature's laws act by the bumps received in the rear of the anatomy.

In the instance cited above it is evident that the coefficient of slipping should be as large as 0.69 in

order to prevent disaster and yet the very best experimental data we have for the coefficient of sliding friction of one stratum of smooth stone on another stratum is between 0.4 to 0.5 as taken from the well known experiments of Morin as listed in Troutwine's "Engineer's Pocket Book."

In reviewing mentally the mammoth dams so soon to be built in the west these two serious disasters are horrible examples to ever bear in mind. The time is now at hand when each western State should have a duly deputized inspecting engineer whose duty it should be to check over the computations and pry into the construction of projects of magnitude of this sort. This would mean safety and security guaranteed to life and porperty and at the same time would give added confidence to investors.

Indeed, without corrective steps undertaken at once to insure safety of life and property in the future, there will be no dams by a power site and wide awake promoters should realize that possibly there may not be forthcoming the money for power by a damsite!!

Some Simple Arithmetic

The proposed power projects in the West which are daily announced in the press, cause many serious thinkers to wonder where on earth a market can ever be found to utilize such an enormous output of power contemplated in these vast development schemes. It is interesting to use a little simple arithmetic and the problem is easy of solution.

In the enterprising city of Ontario in southern California an underground system of supply conduits has been scientifically constructed and in successful operation for many years. It has been found that a rancher owning ten acres of land in combination with twenty-nine other ranchers owning each ten acres of land can successfully and properly irrigate his land for citrus fruits and for small farm products by the use of but one share in a joint ownership of thirty miner's inches of water. The water is scientifically applied day and night and no appreciable waste of any sort is allowed.

What does this mean?

It means that one-tenth of a miner's inch of water under scientific application is amply sufficient to irrigate an acre of arid land. Thousands—yes, millions of acres of arid lands are available for irrigation in the West by raising the water from 60 to 180 feet. Such choice lands readily bring from $150 to $250 per acre when properly watered, while in their arid state they go begging at from $15 to $25 per acre It is true that the duty of water will in general vary with character of soil, crops to be raised, natural rainfall and other variables, but the Ontario example is illustrative of what scientific application can do.

One miner's inch of water is by statute 1.5 cu. ft. per min. Hence, since 1 cu. ft. of water weighs 62.5 lbs, to raise one-tenth of a miner's inch of water 60 ft., will require $\frac{62.5 \times 1.5 \times 60}{10} = 56.2$ foot pounds of energy every minute of time. Let us suppose that our electric pump operates at 50 per cent efficiency. Hence, to irrigate one acre of ground will require 1124 foot pounds of energy every minute. But it requires 33,000 foot pounds of energy utilized every minute to consume one horsepower. Hence to properly irrigate an acre of land under scientific development, raising the water 60 ft. requires but 0.0341 of a horsepower.

The remarkably steady operation of electric pumps necessary in scientific irrigation makes a most ideal hydroelectric load—for the load is even and uniform day and night. The horror of unwieldly peaks never stares the operating manager in the face when supplying power for electrically operated pumps planned for the scientific and economic irrigation of arid lands. Such being the case profits can be realized in the sale of power at the lowest rates. A rate of $30 to $40 per horsepower per year for such a load as is proposed, would make big dividend payers to nearly all the proposed hydroelectric installations which have been favorably reported upon by competent engineers. Assuming a rate of $40 per horsepower per year, this would mean a cost for power of but $0.0341 \times \$40.00 = \$1.36$ per acre per year; compared to the enormous crops raised on western irrigated lands, this cost per acre is trifling in consideration.

Let us bear in mind for a minute that in the State of Idaho alone, the State engineer has estimated that there are in his State acreages by the millions that can be irrigated by raising the waters not higher than 100 feet. It requires but a small extension of our figures given above to see that not only is this cheap supply of power, causing the desert to blossom as the rose, a substantial profit-making load for the hydroelectric plant but the total aggregate of power that will be eventually utilized in reclaiming the arid lands of the West will require horsepower by the millions.

The San Joaquin valley and districts in the vicinity of Visalia, California, though wonders of accomplishment in lands reclaimed by electrically operated pumps, are but feeble illustrations of the future possibilities of ultimate arid land reclamation by lifting the water.

The city of Los Angeles seems almost on the edge of throwing itself into a fit of distemper in its proposed ideas of floating its enormous power supply soon to be realized from the Los Angeles aqueduct. This enterprising city has long since won the admiration of the world with its strength and vigor. It is surprising that a careful investigation is not being made looking to the utilization of the surplus power along the proposed aqueduct in the way of reclaiming large acreages of beautiful lands awaiting "for little drops of water to be added to the sand, which makes a heap of difference in the price of the lands." Undoubtedly in would be found that the present clouds of anticipation in oversupply of power would be at once dispelled. This solution would not only be interest paying for water bonds outstanding, but would add to Los Angeles fruitful and populous valleys which would pay her eternal tribute.

The carefully planned government projects of the Dakotas and the Flathead Indian Reservation project of Montana are illustrations of future possibilities to be realized in scientific utilization of every foot-pound of available energy. It behooves those interested in vast power projects to be wide awake to the possibilities of irrigation.

PERSONALS.

Thomas Mirk, of Hunt, Mirk & Co., has returned to San Francisco from San Diego and Los Angeles.

A. B. Cass, president of the Home Telephone & Telegraph Company, Los Angeles, is at San Francisco.

C. L. Chamblin has joined the office force of the California Electrical Construction Company of San Francisco.

F. N. Averill, manager of the Portland house of the Fobes Electric Supply Company, is at San Francisco.

E. G. Williams, the construction manager of J. G. White & Co., has just arrived at San Francisco from New York.

H. W. Beecher, manager of Chas. C. Moore & Co.'s Seattle office, has returned from an extensive trip throughout the East.

H. V. Carter, president of the Pacific States Electric Company, spent the past week at Los Angeles and Monterey.

C. L. Cory, has returned to his San Francisco office, after a business trip covering Los Angeles, Santa Barbara and Sacramento.

Frank Fowden, manager of the Brooks-Follis Electric Corporation, has returned to San Francisco from a flying trip to Los Angeles.

C. H. Pennoyer, Pacific Coast Manager of the National Conduit & Cable Company, spent several days last week in Los Angeles.

C. R. Ray of Medford, Ore., who was for several years manager of the Rogue River Electric Power Company, is at San Francisco.

W. H. Leffingwell, engineer for the Nevada Valleys Power Company, is at Reno on business connected with the new development.

Charles N. Black, general manager of the United Railroads of San Francisco, has been spending a few days in the mountains on a hunting trip.

J. B. Clarkson and W. B. Lewis are again on the road for the Western Electric Company after spending several days at the San Francisco branch.

J. W. Perry, manager of the electrical department of the H. W. Johns-Manville Company, is at Seattle on his way East, after a tour of the Pacific Coast.

H. E. Hudson, sales manager for the Thomas A. Edison Company, Inc., spent the past week at San Francisco in the interests of the Edison primary batteries.

Henry T. Scott, president of the Pacific Telephone & Telegraph Company, has returned to San Francisco after spending several weeks in the Eastern States.

J. W. Gilkyson, commercial superintendent of the Pacific Telephone & Telegraph Company's Southern Division, was a recent arrival at San Francisco from Los Angeles.

Patrick Calhoun, president of the United Railroads, will be at San Francisco during the coming week and will attend the annual meeting of the company, November 22.

H. J. Baker, of the Hunt-Mirk Company, has returned to San Francisco, after spending several days at Pasadena, installing another unit for the municipal lighting plant.

C. G. Pyle, Los Angeles manager for the Standard Underground Cable Company, is receiving the congratulations of his many friends upon the arrival of a baby daughter.

George Drew, who was formerly connected with the General Electric Company, will join the sales force of the Pacific States Electric Company during the latter part of November.

H. L. Davis has joined the San Francisco sales force of The Ideal Electric & Manufacturing Company and Pittsburg Transformer Company with offices in the Rialto Building.

Chas. H. Sheldon, formerly of Kewanee, Ill., was a visitor in San Francisco this week on his way to Los Angeles, where he will establish himself in a manufacturers' agency business.

Wynn Meredith, Pacific Coast manager for Sanderson & Porter, is expected to return to his San Francisco office during the coming week after a long stay in British Columbia in connection with engineering work.

H. A. Lardner, manager of the Pacific Coast office of J. G. White & Co., of New York, spent the past week on an inspection tour through the interior of California, accompanied by C. J. Rhodin, the firm's hydraulic engineer.

Frederick Pratt and Harold Pratt of New York, who are heavily interested in the securities of the Great Western Power Company, were recent visitors at the Las Plumas power station. They were accompanied in their inspection of the plant by P. T. Hanscom, the general superintendent.

Roscoe F. Oakes, president of the American Ever Ready Company, with headquarters at San Francisco, offered a handsome silver cup as one of the trophies contested for at the golf tournament at Del Monte this week preceding the golf dinner of the Electrical Jobbers Saturday night, Nov. 18.

F. J. Cram, manager of the sales department of the Electric Appliance Company, has returned from an extensive Eastern trip, in the course of which he visited a number of the factories for which his firm are handling specialties. He attended the annual convention of the Jovians at Denver.

G. F. Chellis, an electrical engineer connected with J. G. White & Co., is at Bakersfield in conection with the starting up a new Allis-Chalmers steam turbine unit for the San Joaquin Light & Power Corporation. The steam end of this generating unit is rated at 5,000 kw. and the generator at 6,250 k.v.a. This, in addition to the small steam turbine already in use, gives the steam plant a total capacity of 7,000 kw. at 80 per cent power factor.

Chas. H. Sheldon, manufacturing agent for Southern California, representing the Kewanee Boiler Company of Kewanee, Ill.; Kewanee Water Supply Company of Kewanee, Ill.; Whirlpool Mixer & Machinery Company, Milwaukee, Wis.; Pfaustiehl Electrical Laboratories, Chicago; Bourne-Fuller Co., Iron and Steel, Cleveland; Federal Steel Fixtures Co., Chicago, will open offices at once in Los Angeles, 705 Auditorium Building.

A GET-TOGETHER ELECTRICAL LUNCHEON.

As a result of P. S. Dodd's suggestion that a permanent organization of electrical men be formed at San Francisco, the temporary committee has made arrangements to hold the initial meeting at a local cafe on November 28. On November 14 a meeting of the representatives of the contractors, jobbers, manufacturers and central stations was held at the offices of the Journal of Electricity, Power and Gas and plans formulated for binding these allied interests into one organization, whose prime purpose is to educate the people in the use of electricity.

The meeting on November 28 will be addressed by Albert H. Elliott on the subject of co-operation, with five-minute talks from W. S. Hanbridge, T. E. Bibbins, Geo. C. Holberton and Andrew Carrigan. Attendance at this first meeting will be by invitation, but as soon as the project is launched every man interested in boosting the sale of electric current and apparatus is invited to join in the organization.

This will probably be formed as a local branch of the Commercial Section of the National Electric Light Association.

ELECTRICAL CONTRACTORS' NOTES.

Seth Cohn of the Atlas Electric Company of San Mateo, was at San Francisco last week.

The iron work for the Standard Oil's new building has been let. The contract amounted to $67,438.

Frank Somers, manager of the Century Electric Company of San Jose, was at San Francisco last Wednesday.

A modern hotel building is planned for the northwest corner of Ellis and Taylor streets. The cost will run $300,000.

H. C. Reed, manager of the electrical department of the Pacific Fire Extinguisher Company, has returned from a business trip to Portland.

Los Angeles contractors expect to have a large gathering of southern contractors at the electric show which takes place there between November 25th and December 9th.

L. H. Sly is building a $500,000 apartment house on the corner of Powell and California streets. Mr. Sly in the past has erected a number of large buildings. In all of his building operations he uses non-union labor.

A. E. Brooke-Ridley has been awarded a contract amounting to approximately $1000 for electric wiring in the building on the corner of Market and Stockton streets, which is occupied by Roos Bros.' and Goldman's stores.

The Butte Engineering & Construction Company has been awarded the contract for erecting seven steel illuminating arches on one of the principal streets of Marysville, Cal. The arches will be similar to those in use on Fillmore street, San Francisco. There will be 120 incandescent lights on each arch and a tungsten cluster in the center.

A few suggestions in reference to developing a store trade:

The question is—How shall the contractor develop this electric store out of his present business? And the answer is advertise and by advertising, I mean, do everything that you can think of to make your store popular and profitable. Advertising does not mean printed matter or large expenditures of money, but any one of the thousand little schemes to make men and women buy. After you have secured the best available location, had your store attractively decorated and installed a real salesman, do this sort of thing:

Put cards in your windows explaining what the appliances are for, how much they cost to run an hour, and the price. Remember the public is ignorant of these things and often does not even recognize a toaster or a vibrator.

Hang a cigar lighter over the counter with a card reading: "Light your cigar here."

Follow the weather and the seasons. On a boiling hot day put a battery of fans on a table just inside your door to blow out over the sidewalk. And during the cold snaps set a luminous radiator on the counter with a card "Warm your fingers here," and turn it on whenever there are customers in the store.

Back this up in your newspaper advertising. Make it seasonable and talk about one thing in an ad.

Have sales of irons, heating pads or fans when the weather gives them especial appeal. Sell them cheap for a day and advertise the price.

Use street car cards occasionally, but don't waste money by putting them on lines running through sections of the city where there are few logical prospects for the goods advertised.

Make your windows work all the time. Keep them always new and interesting. It isn't so hard if you give it a little thought.

Have the appliances all connected ready to run and when you get in something new, say a drink mixer, call up the druggists and the cafes and arrange to trot it around and show it to them.

Lay out a schedule of seasonable business, month by month, on cards, so you can always have a reminder before you. For instance:

Don't forget to canvass livery stables just before ice comes and sell them emery motors for grinding horseshoe caulks. Blacksmiths will look long on the forge blower at the same busy season.

Push the vacuum cleaner hard at spring and fall house cleaning time.

Go after the bottlers of beer and soft drinks when the hot weather first commences. It is hard to get their attention during the rush, but bottle washers should be most attractive at the close of spring.

There is one best time to sell most every electrical appliance, and the profit is largest right then because it costs less to sell. Work up a twelve months' plan of campaign and decide that you'll be the most enterprising merchant in your city, and you will be.

In short, it's high time for the contractor to take hold of his business with both hands, both feet and his whole brain, and make his sign mark the headquarters for electrical merchandise. There's an important question to be answered in this country before long and that is—Who is going to own the electric store?

Don'ts for Electrical Contractors.

Don't close your private office door and leave word you are not in. If you are out open the door and leave it open.

Don't refuse to see anyone that calls. You may not recognize real business when it comes in. The most important men are most easily interviewed.

Don't tell a collector that you have not had time to look over his bill when the account should have been checked up and paid sixty days previous. He knows your game and would rather you would tell him you can't pay it.

Don't promise a man you'll mail him a check unless you mean it. He depends on your promise and is up against it if you fail him, and incidentally puts you down as N. G.

Don't talk about the new job you have and how much material you will have to pay for it to the man to whom you owe three months bills. He is on from the minute you open your mouth.

Don't think that these don'ts don't apply to you. There are only a few men in each locality who need not take them to heart.

Don't think that these are all the don'ts that there are. There are more coming. "An Old Timer."

NEW CATALOGUES.

The J-M Packing Expert for October has appeared in print. The pamphlet attractively illustrates products of the H. W. Johns-Manville Company, of Cleveland, Ohio.

The Westinghouse-Church-Kerr and Company have just issued an interesting and attractive publication entitled Central Power Stations. The booklet describes and illustrates the engineering installations supervised and constructed by this company.

G. A. Wilbur, of San Francisco, agent for the Duncan watthour meters, manufactured by the Duncan Electric Manufacturing Company, of Lafayette, Indiana, is distributing bulletin No. 21, just published, on instructions for installing, reading, cleaning, repairing and testing Duncan watthour meters of the direct current.

The popular line "National" metal molding is the subject of a new bulletin just issued by the manufacturer, National Metal Molding Company, at Pittsburg. Prominent among the improvements featured is the substituting of the "key-hole" slot in place of the round punching, which change furnishes a basis for standardizing the fittings, the variety of which is thereby lessened.

INDUSTRIAL

A MODERN ELECTRICAL REPAIR SHOP.

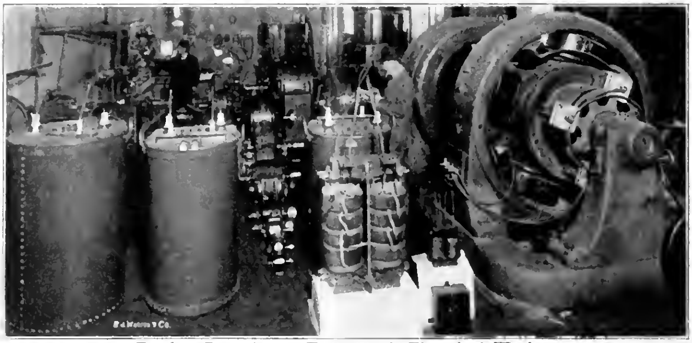
The Farnsworth Electrical Works of San Francisco is operating one of the largest electrical manufacturing shops of the West, employing about twenty-five men. They also carry a large stock of new and second-hand apparatus for sale and for rent, as shown in the accompanying illustration.

The shop is modern and well-equipped with all kinds of iron and wood-working tools, including lathes, planers, shapers, drills, saws, winding machines, taping machines, steam baking oven and two 10-ton cranes serving the entire shop. Much of this apparatus was designed and made in this shop Individual motor drive is used for all tools except where group drive is moro advantageous, twelve motors ranging from ½ to 10 h.p. being employed.

The testing department is well equipped to give a final running test to all apparatus ranging in size from a 1 10 h.p., 100 volt, d.c. motor to a 250 kw., 11,000 volt, a.c., 1200 volt, d.c. railway motor generator set. The board is equipped for switching from 110, 220 and 500 volt direct current and any voltage up to 2400 alternating current, one, two or three-phase. This wide range of a.c. voltage is obtained by means of specially built 125 kw. polyphase transformers and regulator heads, also constructed by the company. Furthermore, the company has designed and made a special high voltage transformer giving a range up to 30,000 volts for insulating tests. These special transformers are situated in a fireproof concrete vault in the basement and current is taken from the San Francisco Gas and Electric Company's mains at 2400 volts a.c. and 110-220 volts d.c. The 500 volts d.c. is obtained from a motor generator set on the premises.

All d.c. and a.c. small machines are given the regulation running and insulation tests and where necessary they are belted to a shop generator to give full load conditions. All a.c. high voltage machines are given the standard A. I. E. E. tests with double voltage on the coils to ground and are then run under full voltage conditions.

One of the most important lines of this company's work is that of redesigning and reconstructing obsolete types of apparatus so as to be adapted to present day usage. A recent example was the reconstruction of a 250 kw., 1100 volt General monocyclic generator into a three-phase, 60 cycle, 2400 volt machine which has been in constant use since reconstruction with perfect results. Recently also a 250 kw. revolving armature Westinghouse generator was redesigned to work in multiple with the General Electric machine.



Testing Department Farnsworth Electrical Works.

Sales Department Farnsworth Electrical Works.

The manufacture of transformers of all voltages and all sizes is another important and growing branch to which special attention is being devoted. One of the illustrations shows three 50 k.v.a. station type, oil-cooled transformers, 11,000, 10,450, 9900 volt primary, 2200 volt secondary, and also one 220 volt primary, 27½ volt secondary Mazda lamp transformer. Apollo silicon steel is used in these transformers and it is claimed that their design is such that they compare favorably in efficiency, regulation and losses with any standard make now on the market. The low voltage transformers are manufactured in sizes from 250 watts to 10 kw. and high voltage transformers can be supplied in any size up to 100 kw.

Especial attention is paid to the needs of construction contractors, a full line of motor-driven hoists, crushers and centrifugal pumps being carried either for rent or for sale.

Inasmuch as over 12,000 jobs have been handled by this firm, they have collected a most valuable fund of information on the construction and characteristics of all makes of electric motors and generators. Consequently they are peculiarly well equipped to advise on the redesign of old apparatus and their mechanical facilities enable them to perform this work quickly and well. In addition to the repair and construction of apparatus, they are also equipped for its installation in industrial establishments, having recently installed a number of complete power plants.

TRADE NOTES.

The Jeffrey Manufacturing Company of Columbus, Ohio, manufacturers of conveying machinery, power transmission machinery and coal mine equipment, have recently opened a branch office at 1201 American Bank Building, Seattle, for the handling of their business in the Northwest. This office is in charge of Percy E. Wright, one of the engineers from the home office. who has been with the Jeffrey Company fcr the past ten years, and has spent the past year in Seattle and the northwest territory.

The Southern Pacific Company has just purchased from the General Electric Company two 25-kw., 125 v., 125 v. Curtis turbine generating sets for baggage car train lighting.

The Mount Hood Railway & Power Company of Portland, Oregon, has just placed an additional order for structural steel with R. A. Deutsche, president of the Structural Steel Company of Seattle.

Southern California Edison Company have placed an order with the American Steel & Wire Company, for approximately 1,600,000 lbs. of 4/0 bare copper strand, for transmission lines, between Los Angeles and Colton and Long Beach and Los Angeles.

In the issue of October 28th, a typographical error was made in the advertising columns of the Journal of Electricity, Power and Gas in stating that the Crocker-Wheeler Company's experience dated back to 1880. This energetic company, with its world-wide experiences, does not, however, date back beyond 1888.

The Tacoma Gas Company has awarded a contract to the Stacy Company of Cincinnati, Ohio, for the construction of a gas tank. The tank will have a capacity of 1,000,000 cubic feet and will be built on the tide flats adjoining River street, and will be connected with the present tank by means of a 24-inch pipe line.

The Hydraulic Engineering Company of Maine have ordered the following apparatus from the General Electric Company for the Mississippi River Power Company, Keokuk, Iowa: 12 waterwheel driven three-phase generators having an aggregate capacity of 108,000 kw.; 12 three-phase water-cooled 110,000 volt transformers having an aggregate capacity of 108,000 k.v.a.; two water wheel driven exciters, one induction motor driven generator, and switchboard.

The Faries Manufacturing Company, Decatur, Ill., the largest manufacturers in the United States of Faries patent adjustable brackets, portables and shades, has just issued a beautiful new catalog showing a complete line of their material. The special feature of this catalog is their adjustable brackets, adjustable portables with green glass hood, and dresser portable; also Mazda clusters with porcelain or steel enameled reflectors, which can be wired for either multiple or series lighting, and for 25, 40, 60 or 100 watt lamps. The Faries Manufacturing Company has just filed an application for a patent on a new style shade holder to be used upon their complete line of shades. These shades are now being manufactured and sold under the Patent Applied For Act.

BOOK REVIEWS.

Direct and Alternating Current Manual. By Frederick Bedell, Ph.D. and Clarence A. Pierce, Ph.D. Size 6 x 8 inches; 360 pages; thoroughly illustrated; cloth binding; second edition, enlarged. Published by the D. Van Nostrand Company of New York, and for sale by The Technical Book Shop, Rialto Bldg., San Francisco. Price, $2.00.

Frederick Bedell and Clarence A. Pierce, as authors of this manual, need no introductory remarks setting forth to the engineering world their fitness for the matter contained within the covers of this book. This manual is a second edition, enlarged, of a former publication. It consists of a series of tests on direct and alternating current apparatus, selected with reference to their practical usefulness and instructive value. A new feature of the edition just published is the matter written on wave analysis. This important subject is too frequently left in the background, for the recluse. The illustrative problem based upon the work of Runge appearing on pages 335 and 336 will be found most helpful for those desiring an exact method of procedure in wave analysis and who are a little unsteady on their feet as to a systematic method. Finally, the relieving feature of the book is that while it deals with thoroughness in such matters as come up for discussion it does not attempt to be exhaustive or complete; on the contrary every effort has been made to eliminate matter of secondary importance, thus giving to the student the very juice of matter discussed without the burden of exhaustive details.

The Design of Static Transformers. By H. M. Hobart, M. Inst. C. E. Size 5½ x 8½ in.; 174 pages; 102 illustrations; clear type; cloth binding. Published by D. Van Nostrand Company of New York, and for sale by The Technical Book Shop, Rialto Bldg., San Francisco. Price, $2.00.

H. M. Hobart presents to the practical engineering world in this book a much needed treatise on the transformer. The book is devoid of theory throughout and the reader is advised to consult certain standard treatises on the subject should he desire to review certain points not understood in the assumptions made by the author as basis of computation and design. Actual numerical problems are carried out in thoroughness and detail. Few typographical errors are encountered. The book being written by a British engineer savors somewhat of usage and practice in vogue in England and the continent, but it will be extremely useful in America to those engaged in practical design of the transformer.

Testing of Electrical Machinery. By J. H. Morecroft and F. W. Hehre. Size 5½ x 8½; 154 pages; 46 illustrations; cloth binding. Published by D. Van Nostrand Company of New York, and for sale by The Technical Book Shop, Rialto Bldg., San Francisco. Price, $1.50.

The authors of this book, engaged in the electrical engineering faculty of Columbia University, have written its contents with the idea in view of meeting a peculiar combination found at the New York University, namely, to devise a series of notes on electrical testing suited to the needs of students pursuing a non-technical course. The book outlines twenty different experiments in all, eleven of which are devoted to direct current apparatus and the remaining nine to alternating current work. A preliminary lecture precedes the detailing of each particular experiment, setting forth the theory underlying the apparatus to be tested. The book is not as tense in its mathematical reasoning as is usually encountered in works of this sort. For this reason the work is especially adapted to that large class of readers outside of our technical school who desire to get a fundamental grasp of the subject without the usual severe mathematical battle encountered in most works of a similar nature.

Electric Central Station Distribution Systems. By Harry Barnes Gear and Paul Williams. Size 5½ x 8½ ins.; 347 pages; 139 illustrations; clear type; cloth binding. Published by D. Van Nostrand Company of New York, and for sale by The Technical Book Shop, Rialto Bldg., San Francisco. Price, $3.00.

Harry Barnes Gear, general inspector of the commonwealth Edison Co. of New York, and Paul Francis Williams, assistant general inspector of the same corporation present in this book a wealth of ideas covering their experiences in the design and construction of electric central station distribution systems. The nucleus matter contained in this publication formally appeared serially in the Electrical Age during the years 1908 and 1909. The treatment is based upon the assumption of a general knowledge of electrical theory such as is possessed by the more advanced students of engineering and by men in practical distribution engineering work. Much of the subject matter of the book is, however, of such a nature as to be easily grasped by practical men who have not had a full theoretical training. The chapters on underground construction and cables coupled with the chapter, on distribution economics represent most recent practice in congested centers of the east and will be found valuable to western engineers now meeting with similar problems.

NEWS NOTES

INCORPORATIONS.

NEZ PERCE, IDAHO.—The Lewis County Electric Company, capital $200,000, with headquarters at this city, has been incorporated with C. F. Cunningham as agent.

OLYMPIA, WASH.—Articles of incorporation for the West Coast Railway Company, to be built between North Yakima and Seattle to connect with the Oregon-Washington Railroad & Navigation Company, in King County, have been placed on file with the secretary. The incorporators are Robert Strahorn and A. Smith. The capitalization is $1,000,000. The road is to run through Yakima, Kittitas, Pierce and King counties. It is to be either steam or electric.

MEDFORD, ORE.—Medford is taking great interest in the proposed electric line to run from Ashland to Eugene, incorporated in the State of Washington with a capital stock of $3,000,000 under the name of the Oregon Southern Railway Co. J. Arnold Doyle of Spokane, Wash., and H. M. Farren of Boise, organizers of the company, are in Medford and will apply for a franchise from the City Council at the next meeting.

FINANCIAL.

SEATTLE, WASH.—The Seattle Lighting Company has been granted a 50-year gas franchise by the county commissioners covering territory south of Seattle.

CRESWELL, ORE.—Local citizens have pledged financial support in the sum of $25,000 to the Eugene Belt Line and Interurban Railway and that company will construct an extension into this city.

EUGENE, ORE.—It is expected that contracts for the construction of the first 25 miles of the Eugene-Coos Bay extension will be awarded shortly. The right of way has been practically secured and contracting firms are submitting bids.

HUNTINGTON PARK, CAL.—At a public mass meeting held by the citizens it was decided to campaign for issuing $60,000 in bonds for a municipal water plant, $10,000 in bonds for a municipal electric plant, $10,000 in bonds for a fire apparatus.

MYRTLE CREEK, ORE.—At a special election the people of Riddle voted $15,000 bonds for a water works system, the old plant being inadequate; and $13,000 for a complete sewer system. Both issues were carried by a large majority. Construction work will begin as soon as contracts can be let and the bonds sold.

SAN FRANCISCO, CAL.—One hundred bonds of the San Francisco Gas & Electric Company have been retired, the numbers having been drawn by lot under the terms of the trust mortgage of August 20, 1903. The bonds are part of the 30-year gold bonds of the company's sinking fund, and date from November 1, 1903.

VISALIA, CAL.—G. V. Reed, A. C. Tienken, G. R. Hostetter and F. F. Hostetter, directors of the Lindsay Gas and Water Company, have petitioned the Superior Court for the dissolution of the corporation. The company was capitalized at $75,000 divided into 1500 shares of the par value of $50 each. The petition states that 534 of the shares have been sold.

MARTINEZ, CAL.—A rate war is on in Concord between the Pacific Gas & Electric Company and the Great Western Power Company, which recently entered the Contra Costa field to compete with the former established company. The Great Western is cutting rates on light and power below the schedule now in force with the Pacific Gas & Electric Company, and to retain the business the latter company is reducing its rate to meet that of the new-comer. Manager Don C. Ray of the Martinez district is making earnest efforts to retain this business for the company. The power line of the Great Western has been completed along the water front from Concord through Martinez and Port Costa to Eckley.

HOLTVILLE, CAL.—The City Council has passed an ordinance providing for an election to be held November 29 to vote on the question of issuing bonds for completing the construction of the water works system of the city and for acquiring or constructing fire apparatus. The issue is to be in the amount of $10,000, of which $8000 will be for the water system and $2000 for fire apparatus.

McMINNVILLE, ORE.—Three charter amendments providing that the city issue bonds to the amount of $75,000 have been passed by a large majority at the city election. The amendments are as follows: Authorizing a bond issue of $15,000 for replacing wooden water mains with iron; authorizing bond issues of $30,000 respectively for street improvements and extension of water and light systems.

SAN FRANCISCO.—The finance committee of the Supervisors consented last week to let the Board of Public Works have $7000 additional for laying high-pressure mains by day labor in Second street, between Market and Townsend. The committee also allowed $11,000 in addition to the $10,000 originally given for purchasing cast iron pipe for the Ingleside outlet sewer across Lake Merced rancho. The first amount was set aside on the city engineer's estimate which proved too small.

SAN BERNARDINO, CAL.—The Lytle Creek Power Company of this city has been absorbed by the Southern Sierras Power Company. The latter company paid $160,000 for the property. The Southern Sierras Company is engaged in building a high power transmission line from Bishop Creek, in Inyo County, to San Bernardino, a distance of 240 miles. This will probably replace the supply now being furnished the Lytle Creek system from a steam plant. The Lytle Creek Power was organized seven years ago by local men.

SAN FRANCISCO, CAL.—The San Francisco, Vallejo & Napa Valley Electric Railroad, having defaulted in the interest on its $1,500,000 of bonds, has been sold for $700,000 at public auction. The purchasers will have to take care of a floating debt of $400,000. Three bids were received, one for $500,000, a second for $600,000 and the third for $700,000. The first and third bids were made by a bondholders' committee, consisting of James Irvine and John D. McKee of this city and George R. Sheldon of New York. McKee is vice-president and cashier of the Mercantile Trust Company.

TRANSMISSION.

HAILEY, IDAHO.—The Kilpatrick Bros. expect to put in a power plant at their dam on Silver Creek in the near future that will furnish light and power for Picabe.

VALDEZ, ALASKA.—Henry Deyo, with a crew of surveyors, will make a survey of the Alaska Water, Light & Telephone Company's power site at Sulphide gulch.

RENO, NEV.—What is intended to be a direct competitor for the power business throughout Nevada now controlled by the Hammon interests which have several million dollars already expended in or applied to its mammoth workings in this State, is the Nevada Valleys Power Company. The articles of incorporation provide for a first capitalization of $2,500,000. This is the initial step taken by a combination of Western capitalists toward the construction of big power

plants on Truckee River. Some months ago a power site was taken over at a point near Vista, east of Reno, and rights of way secured for ditches and reservoirs. The promoters of this project are Milton S. Hamilton and F. J. Early of Oakland and their associates. It is proposed to construct at the outset a plant having a capacity of 4000 h.p. to be directed in immediate opposition to that operated by the Hammon or Truckee General Electric interests. Work of building will begin immediately.

SAN JOSE, CAL.—The bid of the Great Western Power Company of $110 for the power pole line franchise that corporation recently asked for has been accepted and the franchise has been awarded.

EUGENE, ORE.—Joaquin Miller is interested in a big electric power plant project on the Siuslaw River, six miles above Mapleton, and it is announced that the plant will be installed early in 1912. Geo. Melvin Miller, brother of the former, is now in Portland arranging for machinery for the plant.

STOCKTON, CAL.—Robert R. Reed, representing the Sierra and San Francisco Power Company, announces that the company will be in operation in this city by December 1. He declares that the company is building from Manteca, where it has its main line, to Stockton, and that it is within four miles of this city.

EVERETT, WASH.—Reports are to the effect that the Stone-Webster Company is preparing for the installation and construction of a power plant in the Sultan basin, deriving its power from the Sultan River. A large dam will be built in the Sultan canyon and this tract flooded so as to form a reservoir for storage of water.

CENTRALIA, WASH.—The Centralia Light & Power Company, which projects the construction of an electric railway line between this city and Rochester, a distance of 10 miles, has practically secured all rights of ways and a 500 kilowatt turbine generator for use in the power house has been acquired. The power is to be supplied by the Eastern Railway & Lumber Company.

HONOLULU, H. I.—A large contract was awarded recently by the Island Investment Company to the von Hamm-Young Company for the hydroelectric plant which the Island company is building between Wailuku and Kahului on Maui, for the purpose of supplying these towns with electricity and light. The contract is for the machinery and calls for its shipment from the manufacturers in the East within 60 days. The plant is a steam one, and California oil will be the fuel used.

OROVILLE, CAL.—Plans have been completed by the Oro Electric Company for the active beginning of construction work at Humbug early in the spring. One of the first developments will be on Yellow Creek. Last February E. M. Ebright filed on 60,000 inches of the waters of Grizzly, Soda, Butte and Yellow Creeks, and later transferred to Grizzly, Soda, the Oro Electric Corporation. It is the plan of the corporation to assemble the water in a 1700-acre storage resesvoir in Yellow Creek Valley, from which point it will be dropped by means of pipe-lines to the mouth of Yellow Creek on the north fork of Feather River, where the powerhouse will be located.

PORTERVILLE, CAL.—Due to new regulations which have been adopted by the Underwriters of the Pacific and new regulations which have been made obligatory upon light and power service corporations through new legislation which went into effect October 22, the Mt. Whitney Power Company finds itself faced with the necessity of a complete reconstruction of their plant within the ensuing five years. First, the power lines which now exist throughout the district must be completely rebuilt. The new regulations call for a clear distance of 26 inches between the power wires, as strung in the familiar triangular form and the third wire at the top must be placed upon a long iron pin, which will carry the regulation porcelain or glass insulator. The new arms of the poles will be considerably longer than at the present time and the distance between the wires sufficient to allow a safe working space. Another change which is made necessary by the new regulation is in the replacement of all circuit breakers on the line.

TRANSPORTATION.

SOUTH VANCOUVER, B. C.—The British Columbia Railway Company will shortly double-track Fraser street in this city.

MEDFORD, ORE.—J. Arnold Doyle of Spokane and F. M. Farren of Boise, organizers of the Oregon Railroad Company, while here announced that they will soon apply for an electric railway franchise through the valley.

KIRKLAND, WASH.—The Pacific States Telephone & Telegraph Company has announced its intention of extending its Seattle service to this city. An order for cables has been placed with the General Electric Company of New York.

PORTLAND, ORE.—Activities of the Oregon Electric Company officials indicate that the Hill electric system is preparing for early construction of the line from Portland to Newberg, McMinnville, with the Dalles, Ore., as the terminus.

RIVERSIDE, CAL.—The City Council has accepted the offer of $25,000 made by the Pacific Electric Railway Company for a franchise to operate and maintain a double track line over the extension of Magnolia avenue, between Arlington avenue and Main street.

PHOENIX, ARIZ.—The City Council has passed an ordinance granting to the Salt River Valley Electric Railway Company a franchise to construct, operate and maintain for a period of twenty-five years, an electric street railway along certain streets, highways and public grounds of the city.

RIVERSIDE, CAL.—The bond of the Pacific Electric Railway Company for $500 has been approved and an ordinance passed granting a franchise to the Pacific Electric Company for the construction and operation of a double track line over Magnolia avenue from Arlington avenue to the intersection of Main and Fourteenth streets.

SAN FRANCISCO, CAL.—Manager George Hark of the Reno Traction Company is in San Francisco to confer with the directors of the company concerning the building of an extension of the electric line from Sparks to the Arkell mine in the Wedekind district. He says that the line may be built immediately for passenger and freight traffic, to haul the ore from the mining district.

LOS ANGELES, CAL.—The Pacific Electric Railway has a large construction force at work rebuilding the Sixteenth street line of the road within the city limits, as far as Rosedale cemetery. The work is under the immediate supervision of Assistant Chief Engineer E. C. Johnson. The roadbed which is being laid is comparable with that put down on Broadway by the Los Angeles Railway Company, which cost approximately $110,000 per mile.

FRESNO, CAL.—Although it is expected that ties for the Fresno, Hanford & Summit Lake Interurban Railroad will be in Fresno by the 15th of this month, another postponement in the beginning of track laying is announced, because it will be impossible to get rails here before the 1st or 15th of December. Efforts were made to secure between 600 and 700 tons of rails in San Francisco, but investigation showed that more than 25 per cent of them were short rails and unsuited for the requirements of the road. Inability to use these rails has made it necessary to get the entire supply of about 4500 tons from Pueblo and they will not begin to arrive here before December 1.

SAN JOSE, CAL.—At the regular weekly meeting of the Town Trustees of Alviso rights of way over the two principal Alviso streets were granted to the San Jose Terminal Railroad Company, which has announced plans to build an interurban road connecting San Jose and that place. The plans call for the immediate beginning of work and rights of way have now been secured for the entire 12 miles of line. The projectors of the new road plan to make a summer and winter resort of Alviso and it is expected that the old water route to San Francisco will be revived as a passenger and freight line with the opening of the road. John A. Mehling, E. M. Rea and M. J. Gardner, officers of the company, presented the petition of the company to the Alviso trustees.

FAIRFIELD, CAL.—For the purpose of building a railroad from Cement to Tidewater, touching the slough at a point near Rush's landing, about two miles south of Suisun, the Cement, Tolenas and Tidewater Railroad Company has been incorporated. Articles of incorporation were filed with the county clerk. The life of the company is 50 years and the capital stock $500,000 divided into 5000 shares at a par value of $100 each. The sum of $6000 has been subscribed and paid into the treasury. R. B. Henderson, A. D. Plaw, W. T. Barnett, Paul C. McCarthy and F. D. Madison are the incorporators. Grading for the line was commenced about two years ago, but work was suspended after a few months. It is stated now that operations on the road will again be commenced at an early date.

ILLUMINATION.

COLTON, CAL.—The City Trustees through Attorney Byron Waters have been presented with the application of the Southern California Gas Company for a 50-year franchise through the streets of Colton. C. M. Grow is superintendent of the company.

ENCANTO, CAL.—The agent of the San Diego Gas and Electric Company is canvassing here to see how many residents will utilize gas if provided. From the success he is meeting it is probable that Encanto will soon be connected with the San Diego plant.

ABERDEEN, WASH.—The Council has passed an ordinance granting to the Municipal Heat & Light Company a franchise to construct and maintain upon certain streets and alleys of Aberdeen, pipe lines, wires and conduits for the transmission of light.

WOODVILLE, ORE.—The Town Council has entered into an agreement with the Rogue River Electric Company under the terms of which the company contracts to install an electric light plant complete in the town of Woodville according to the plans and specifications.

EUGENE, ORE.—The city's $25,000 electric street lighting bonds have been sold to local people and the work of installing the lights will begin at once. The people have voted $57,000 more bonds for the further extension of the street lighting system. The latter issue will also likely go to local people.

RIVERSIDE, CAL.—The Southern California Gas Company has filed correspondence with Mayor Evans revealing to members of the Council the purpose of the company to proceed at an early date with extension of its high pressure lines to Arlington; serving both Brockton avenue and residents along the new Magnolia extension.

HUNTINGTON BEACH, CAL.—G. G. Ivy is planning to erect a gas plant here at an early date. He is now securing names of those who will use it. A high pressure system will be used and each block will be so piped that it can be supplied when it is fully built up with houses. One of the gas mains will be laid on Olive ave., branching each way into the alleys, extending from Main to Fifteenth streets, will also be laid in other streets. The generator of the manufacturing plant is to be of a capacity to supply 50,000 cubic feet of gas in ten hours. Mr. Ivy will have charge of the plant.

MADERA, CAL.—Madera citizens are looking forward to having a new gas system in operation in a short time, Contractor F. C. Roberts having arrived from San Francisco and arranged for hastening of laying the mains. It is expected the pipe will all be down in two weeks to prevent interference with street paving work already planned.

NORTH YAKIMA, WASH.—Chief Engineer D. F. McGee, of the Pacific Power & Light Company, and Consulting Engineer D. C. Henny were at the Wapato canal in the Naches recently investigating conditions preparatory to the installation of various improvements and changes. The Pacific Power & Light Company will also improve the local street lighting system. The present old style multiple arc lights will be replaced with modern arcs, and changes will be made in the local substation.

TELEPHONE & TELEGRAPH.

VANCOUVER, B. C.—The British Columbia Telephone Company has plans prepared for extensive telephone improvements here.

McMINNVILLE, ORE.—Carlton's City Council has granted the Carlton Mutual Telephone Company a ten-year have been printed repeatedly.

ASTORIA, ORE.—Grangers in the vicinity of Knappa and Svenson, have decided that to supply the proper service in a long needed telephone line they would organize a stock company, the stock to be subscribed by the farmers and the line to be built and operated by them.

ARCATA, CAL.—F. Blake, proprietor of the Independent telephone line, has been very busy for the past week preparing to build about two miles more of the telephone line which will run out to the mouth of Mad River and will take in the greater number of ranches along the way.

CONCORD, CAL.—A company to be known as the Mt. Diablo Telephone Company has been incorporated here. It is the plan of the directors to construct 22 miles of telephone wires in the country outside of Concord. The lines will run through Concord to the Ygnacio Valley and Clayton. The officers of the new company are: H. C. Wetmore of Concord, president; Joseph F. Frank of Clayton, vice-president; Charles Gordon of Clayton secretary and treasurer.

SAN FRANCISCO, CAL.—Edward J. Nally, first vice-president and general manager of the Postal Telegraph Cable Cimpany, is at San Francisco. Nally's Western trip has given rise to numerous reports that his mission to San Francisco has to do with the Postal's absorption in California of a number of independent telephone companies, with a view to putting the telegraph company of which he is the managerial head on a better footing with its rival, the Western Union, which has taken control of the Bell Telephone Company's interests in this country.

LOS ANGELES, CAL.—It is generally conceded that a sweeping victory for municipalities in the State of California which seek to control telephone companies by franchises, was scored when the Supreme Court affirmed the opinion of Judge Walter Bordwell of the Superior Court, who declared that the city of Pasadena had the right to make the Pacific States Telephone & Telegraph Company take out a franchise in order to operate in that city. In its opinion the Supreme Court establishes a precedent which will in time be the ground for the city of Los Angeles to require the Pacific States Telephone & Telegraph Company to take out a franchise for the right of that company to operate in Los Angeles which terminates in 1916.

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A MODERN FIRE ALARM INSTALLATION

Like nearly all electrical communication systems the modern fire alarm system had its humble beginnings, has progressed through a considerable development stage, and now is coming to be regarded as a field for trained professional effort.

As in the telephone and electric light field, so the early fire alarm systems were developed by telegraphers, or those skilled in that art; but with this important difference, that while the former installations were largely in the hands of private corporations, the latter were, in general, under the control of municipalities, and became, naturally, a part of our political systems, with superintendents appointed more for their political than for their electrical skill.

Little attention was paid to the real development of the early systems, or even, in many cases, to the proper maintenance of their essential features.


A Modern Fire-proof Fire-alarm Building at Oakland, California.

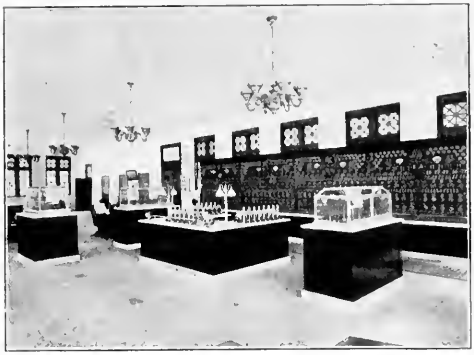
Boxes were allowed to become run down, and the overhead circuits were allowed to rust away until even ordinary storms were sufficient to cripple the system. The central apparatus was placed in some out-of-the-way location, usually in an engine house, with little regard for very important functions, it should be continuously ready to perform.

Oakland, California, was no exception to this

rule of progress. For many years its fire alarm system was the usual combination of obsolete devices in various stages of disrepair, amounting at times to a dangerous condition of inefficiency.

The apparatus was housed on the third floor of a brick building, surrounded by frame structures, incompatible with the nature of the system, and militating against developing efficient service.

But some eight years ago the central office was removed from its loft over an engine house and is now situated in an isolated fireproof steel and stone building of classic design, erected for this purpose in one of the city parks. The building is a single story with a deep basement. The outer walls are Utah sandstone, cream white, soft and easy to work, but of a quality that hardens on exposure. The door and window frames are metal and filled with heavy wire mesh glass. The roofs and floors are concrete, with mosaic finish on the latter, and a fireproof wainscot of beautifully veined Vermont marble.



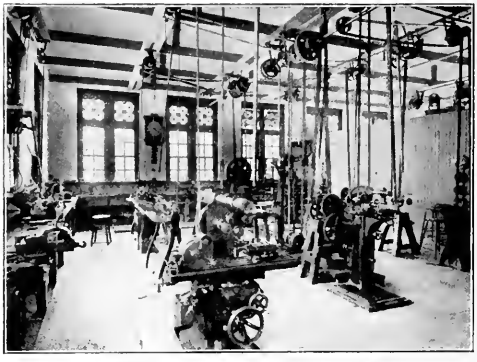
Main Signal Return Room.

The fire alarm equipment consists of four 12 circuit, main line, storage battery, slate-base panels, mounted in steel frame and so wired that the office may be operated either manually or automatically as conditions may require. For automatic operation there are two repeaters which take up the alarm from the fire-box and transmit it through the gong lines to the engine houses. The gong lines are connected in series through each repeater, the operating table, the manual transmitter and the gong panel to the engine houses. For manual operation both the box and the gong lines are brought to the relay and tape registering table shown in the illustration. Here the box circuits are connected to the closed circuit tape machines and relays. Blinker lights are provided to flash their warning to the operator should his attention be distracted from any cause and a telegraph key permits him to signal on the box lines whenever that becomes necessary. The gong lines are also connected with keys on this table. One line passes through a master tape and time registering machine which not only punches the number of the alarm but also at the same time records the time of sending the alarm to the engine houses. When the apparatus is to be operated by hand the automatic repeaters are switched off and the gong lines are operated either through the manual transmitter, or the keys on the relay and tape register table. In addition to the regular gong lines, high speed tapper lines are provided to be used principally for reporting engines out, or returned to service, and they are also used to signal fires. A two-dial, four-plate manual transmitter with which both gong and tapper lines are connected gives perfect control of this service. Thus the engine houses may be signaled by the repeater, by the keys on the table or by the manual transmitter.

The use of the tapper lines is further seen in the operation at the engine houses. The alarm, whether sent out automatically or manually, is there received first on the tapper line at a high rate of speed as a preliminary warning and registered on a tape and is followed closely by the alarm on the gong line given much more slowly. Companies that are not to respond to an alarm, signalled by the tapper, shut off the gong line and all the subsidiary apparatus so that the sleeping men and the horses may not be unnecessarily disturbed, but the man on watch stands ready to get a possible second or third alarm that then must sound on the gong and send the company out.

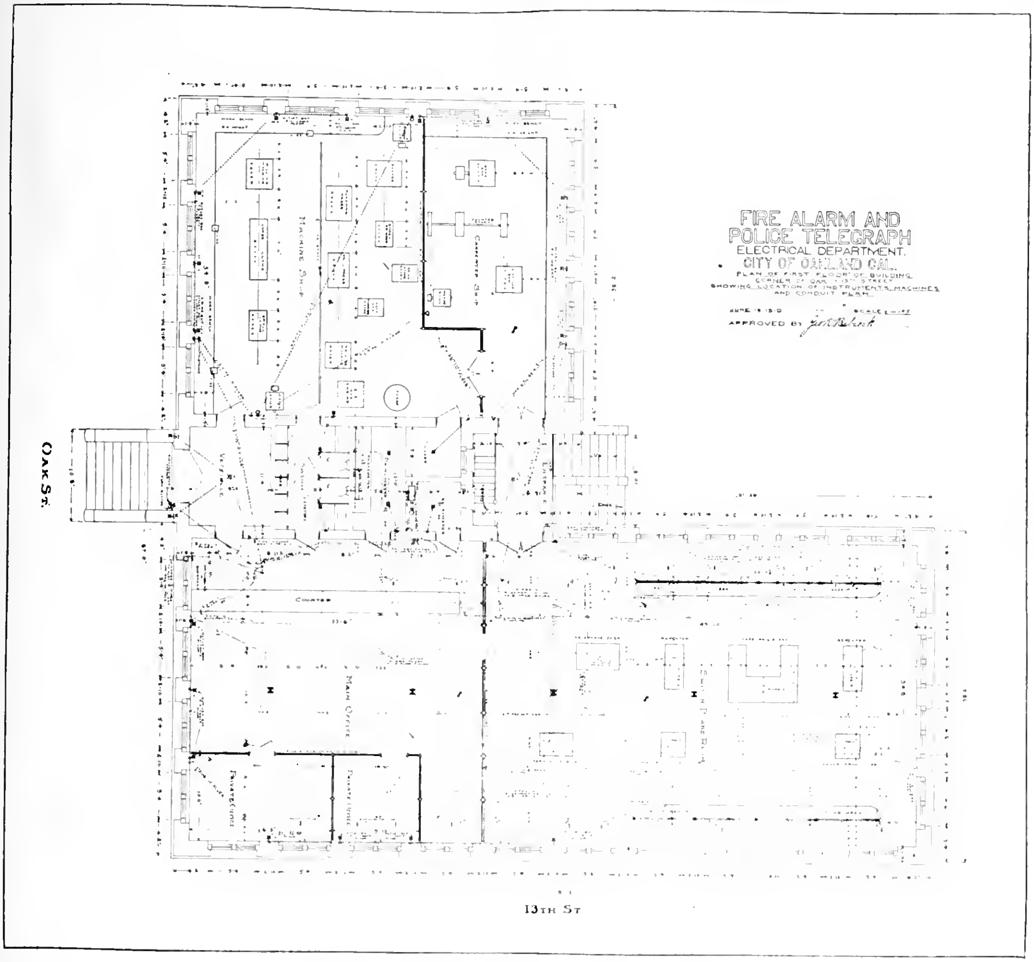
The advantage of the manual system is that the box may be run at a high speed, bringing the alarms into the central office quickly, where they are transmitted quickly to the engine houses. The lines are thereby cleared quickly for the next alarm, a feature of great importance in large cities, where at times one alarm will follow another in rapid succession.

There is also a 100 local 20 trunk, private exchange telephone board (equipped at present to half its capacity) to which all the telephones of the department are connected. Trunks from both the public telephone companies are brought to this board. Through the board all the telephone business of the fire department is transacted, including the reporting of fires independently of box alarms. For the latter purpose two trunk lines are used exclusively and lamps connected to them are equipped with red glass in order to attract the attention of the operator instantly.



Machine Room Where Fire-alarm Boxes are Manufactured.

The storage battery is situated in the basement and is mounted on metal racks and is provided with both glass and porcelain insulation. All wires from battery to board are in conduits and show only at battery terminals; in fact all wiring is in conduit, and, in the case of signal lines, in lead covered cable.



Ground Floor Plan Oakland Fire-alarm Installation.

The laying out of the building conduit system required forethought because the needs of the department for many years to come had to be anticipated. This was successfully accomplished on the checkerboard plan, with traps set in the concrete floor above the basement in such order that any part of the room may be reached from any other part without expensive cutting of floors whenever changes are necessary.

The main room is lighted at night by the indirect system. The reflections from the white walls and ceiling and from the marble wainscot and light colored stone floor gives a diffused and softened light without shadows and without glare.

A large room on the main floor, of the same width as the operating room, but extending back only half as far, is devoted to the shop of the department, equipped with modern tools of sufficient number and variety to enable a great deal of high class work to be turned out at a very considerable saving in money both on repairs and on new construction, and with an important saving in time on emergency work. Shaping machines, drill presses, lathes, emery wheels and milling machines, one of which of considerable size, furnish a wide range of capacity. Castings have to be made outside, but such things as horse releases, tape registers, gongs, fire boxes, police boxes, automomatic lighting switches and many other pieces of apparatus, with all their complex parts are made in this shop in a superior manner and with a material money saving to the city.

As with the housing of the central apparatus, so with the system of wires and cables connecting with the engine houses and other important elements of the fire department. To leave them exposed to the hazard of weather and other causes of overthrow or disruption is as poor judgment as to have no proper center of reception and distribution. As fas as practicable all such wires have been placed underground and the extensions planned will ultimately cover the entire plant. A saturated cable seems to adapt itself better to this

Storage Cells for Oakland Installation.

class of work than the dry paper, as the construction is necessarily of a mixed nature and the aerial lines are subject to contact with high voltage wires of lighting or power companies that would be very apt to puncture the insulation of the ordinary dry paper cable. The service does not demand the low electrostatic capacity of this type of cable, but does demand an uninterrupted communication at all times which the dry paper, on account of its rapid deterioration in case of puncture of the armor, does not offer. An insulation resistance of 100 megohms, if maintained throughout, is sufficient, but a higher insulation is specified because of the difficulty of holding up the terminals in the base of the pedestals of fire alarm boxes to anything like that standard.

When the underground cable system as at present provided for is completed it will consist of over 95,000 feet of lead armored, saturated core cable of from 6 to 180 conductors apiece. About one-third of these conductors are 19 gauge and are twisted in pairs to be used for telephone purpose only. The balance consists of 16 gauge straight conductors and are used for fire box and engine house circuits.

Each separate conductor is insulated with three layers of paper thoroughly saturated with a high grade compound. The insulation resistance of this style of cable varies from 300 to 600 megohms per mile. Considerable difficulty was experienced in obtaining cable of low electrostatic capacity with the saturated core feature. However, as low an average as 0.15 m.f. per mile was obtained on the last order, the first order being rejected because of a capacity of about 100 per cent above that specified.

Underground conduit space is furnished the city by the Home and the Pacific Tel. & Tel. Companies; also position for wires on their poles is furnished when desired. About one mile of underground conduit was laid in districts not covered by either of the two operating telephone companies. The main cables extend from a radius of about 15,000 feet to a distributing frame in the operating room of the fire alarm building. All cables, including the Home and the Pacific Tel. & Tel. Companies' telephone trunk lines, enter the operating room through 200 conductor rubber insulated lead armored cables, and terminate on standard 25 pair terminal blocks mounted on the top of the distributing frame.

Twenty pair fuse mountings equipped with ½ amp. pencil fuses occupy the lower half of the distributing frame. Both the fire alarm box circuits and the telephone switchboard lines terminate on the front of the fuse mountings.

The cross connections are made from the underground cable terminal strip by running flame proof rubber covered wire from the cable pair desired, through enameled rings down to the fuse mountings where connections can be made to any line on the fire alarm or telephone switchboard.

This distributing frame, (capacity 300 lines), is covered with a cabinet having glass doors on the front and back, which render the frame accessible from either side. The top of the cabinet is covered by a marble slab 4 ft. long by 3 ft. wide and has a galvonometer and bridge mounted on it, arranged for locating cable and line trouble. As the distributing frame is located on the same floor and near the fire alarm and telephone switchboard, it is easily accessible to the operator, who can make tests on lines without being called a great distance from his work.

Repeaters, operating table and manual transmitter are mounted on marble bases supported by steel frames as a further protection against fire or damage by high voltage lines.

All the contracts let were for material only. Conduit, switchboards, instruments, wiring and cable, in fact all electrical apparatus connected with the installation was installed by the electrical department of the city; thus the operating force gained a detailed

knowledge of the location and manner of installation of all the circuits. All of the work, both engineering and construction, was carried out under the personal direction of the city electrician, Mr. George R. Babcock.

Reference was made to provision for future expansion of the system. Of course it is plain that so far as laying of conduits and stringing of wires is concerned the growth of the city will offer no special difficulty, but a central station not planned on its establishment for such increase of duty would involve great expense and possible delay. In this installation the future has been considered so that expansion of capacity means but the minimum of installation of new apparatus and of expense. The present capacity is for a city of 200,000 inhabitants to which limit Oakland is fast approaching; but with the duplication of apparatus already installed and without change in the building or in any of the cable systems a capacity for a city of a million of people may easily be obtained.

The progressive spirit displayed by the people of Oakland should meet with general commendation, for it has brought about, among other great improvements, the erection of an electrical building that is one of the handsomest and most modern in the United States. Wherever interest is shown in the care of electrical equipment the electrical building of Oakland is deservedly pointed to as a pattern for this kind of construction. Further provision voted by the people of Oakland for the erection of municipal buildings gives $1,300,000 for the construction of a new city hall—the cornerstone of which has just been laid by President Taft—and allows $3,000,000 for building additional school houses, and authorizes the expenditure of $500,000 for the erection of a magnificent public auditorium.

Oakland has been exceedingly fortunate in her choice of public officials, to whose efforts during the last eight years are largely due the splendid progress she has made and the uninterrupted prosperity she has enjoyed.

SAN FRANCISCO SECTION, A. I. E. E.

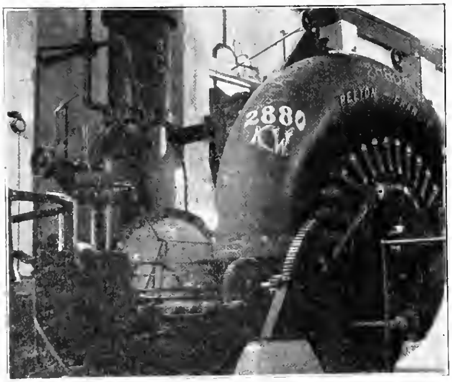
The next meeting of the San Francisco Section of the American Institute of Electrical Engineers will be held at 8 p. m., Friday, December 1, at the Home Telephone Company's building. This meeting has been postponed from the regular meeting date of November 24 on account of the absence of a large number of engineers who will participate in the discussion. The paper for discussion is the "Reconstruction of a 20,000 H.P. Hydroelectric Power Plant," by Geo. J. Henry Jr. and J. H. Hansen. This paper is printed in full on this and succeeding pages in order that everyone may be prepared to discuss it intelligently. As this will be the last meeting of the present calendar year on account of the Christmas holidays and as several matters of importance are to be presented, a full attendance of all members is especially urged. These meetings are open to the public and it is hoped that the civil and mechanical engineers will lend their presence and take part in the discussion. A table d'hote dinner will be served at the Old Poodle Dog restaurant on Bush street at 6:15 p. m. before the meeting.

RECONSTRUCTION OF A 20,000 H.P. HYDRO-ELECTRIC POWER PLANT.

BY G. J. HENRY JR. and J. H. HANSEN.

The Kern River power plant of the Pacific Light & Power Company of Los Angeles has several interesting features, especially with reference to the development and installation of modern water turbines. The plant is situated on the Kern River and is also known as the Borel station of the Pacific Light & Power Company. It consists of five 2500 kw. Bullock generators, which are water wheel driven and form a part of the company's power system, furnishing Los Angeles with electricity through upwards of 150 miles of transmission line.

The water for driving the turbines is taken from the Kern River and carried through a cemented canal 12 miles long to a forebay directly above the power house. In this way a drop of 260 ft. is created and the water is taken from the forebay to the turbines through five 5 ft. diameter steel pipes each 500 ft. long. The plant is reached by an old mountain road 35 miles long, which touches an altitude of 4000 ft.



Showing Operation of Wicket Gates of Pelton-Francis Turbines.

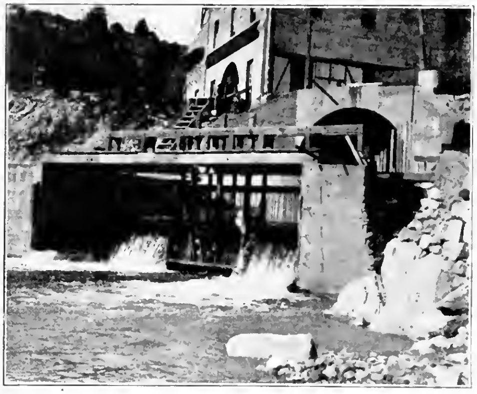
and the plant itself has an elevation of 2500 ft. above sea level.

The original installation consisted of five impulse turbines of the Girard type. The wheels were mounted overhung on the 16 in. shaft extension of the generators and the speed of the wheels was 231 r.p.m. As the power house is situated on a bank about 25 ft. above the river, the wheels were provided with draft tubes and by means of air inlet into the casing, which was regulated through a float valve in the tailrace, the water in the draft tube was to be kept a certain distance below the wheels. After about four years' operation it was decided to take out the Girard turbines, as they did not have the desired efficiency. The operation of the Girard type of wheel under these conditions proved unsatisfactory from the start and many changes were made in the structural features in an effort to better the efficiency and reliability, but without much success. The investment was extremely heavy for the power obtained, so much so as to make steam generation from oil quite attractive; and this combined with the annoyance of constant shutdowns established a strong feeling in the minds of many operators, engineers and managers of Pacific

Coast plants against turbine units in general. Turbines—in fact hydraulic power plants generally,—may be said to be like little Susie who

"When she was good, was very, very good,
And when she was bad she was horrid."

At about this time the problem was presented to the Pelton Water Wheel Company of San Francisco, who, after investigation, recommended a Pelton-Francis turbine for the conditions there involved,



Weir.

although the generator speed of 231 was quite low for this type of wheel. The use of a tangential type of wheel was opposed as entirely unsuited to the conditions. However, the Pacific Light & Power Company placed a contract with another builder for a tangential type of unit, based on guarantees of performance, which in the writer's opinion could never be met by this type of unit. As built and tested, this consisted of two wheels, each supplied with two needle nozzles set in a pit some 9 ft. below the floor line, in order to reduce the draft head to a minimum and increase the pressure head. It is our belief that nothing but disastrous results have so far been obtained, in spite of several changes in the unit, including an abandonment of the use of draft.

The Pelton company was awarded the contract for the four other units, the purchaser taking the precaution to have the first unit built, installed and thoroughly tested, in compliance with guarantees, before authorizing the manufacture of the other three units.

In the design of these Pelton-Francis turbines, with a speed constant:

$$n_1 = \frac{n}{\sqrt{H}} = 14.4$$

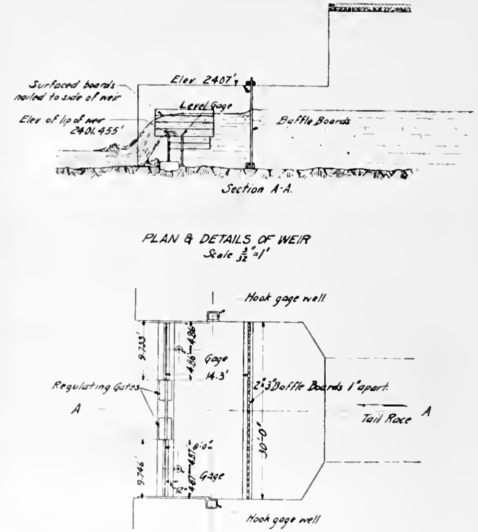
which combined with discharge constant:

$$Q_1 = \frac{Q}{\sqrt{H}} = 10.7$$

gives a specific speed:

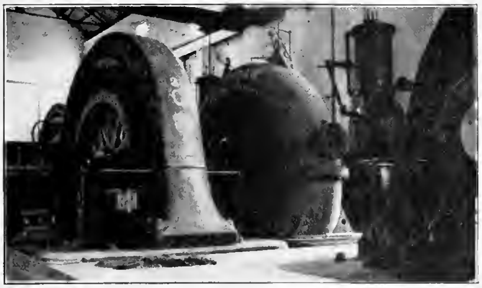
$$n_s = \frac{n\sqrt{hp.}}{H^{3/2}} = 63.5$$

in the metric system or 14.2 in English units, a runner design of rather large diameter (84 in) was necessary, thus making the surface friction and runner and casing clearances rather critical. In other words, the runner is of necessity what is known as an extremely low speed type for the attainment of best efficiencies. The large diameter of the runner of course makes necessary a large diameter of spiral casing weighing upwards of 30,000 lb. and standing 16½ ft. high. This is parted horizontally. The flow of water to the turbine may be controlled by a 42 in. hydraulically operated gate valve. The water passage to the runner is under the control of 32 cast steel wicket gates or guide vanes outside packed and of carefully plotted curvature, to insure good efficiencies at fractional loads. A cast steel gate ring actuated by the governor controls the synchronous movement of these wicket gates through suitable levers and links. The turbine runner is of manganese bronze and great care was taken in the molding to insure smooth water surfaces, being afterwards hand scraped and machined to absolute smoothness. The runner is hydraulically balanced by chambers on each side, but a double disc thrust bearing with automatic ring oiling supply is also provided. The runner discharge occurs over a fixed conical thimble surrounding and protecting the shaft and extending into the draft elbow. The reaction from the runner is thus taken up by this stationary discharge thimble, which reduces the end thrust on the bearing. The draft tube extends from the flange outlet of the draft elbow 27 ft. below the shaft center line, flaring suitably to reduce the discharge velocity to a minimum. The casing covers are made parting to facilitate access. The shaft, where it extends through the packing glands, is protected from wear by a suitable parting bronze wearing shield, which can be readily replaced. The water passage between the wicket gates and runner is protected by bronze liner plates readily replaceable in the event of wear. Aside from the adjustment provided for the wicket gates, the connecting rods between the gate ring and governor rockshaft are adjustable.



Plan and Details of Weir.

In most installations a synchronously operated relief valve is direct connected to this rockshaft to prevent water hammer in the pipe line due to the governor's action at load changes. In this particular plant, however, the governor works directly on the wicket gates, but is set to make the stroke slow enough to prevent a material pressure rise in the short pipe line.



Pelton-Francis Turbine Erected at Plant.

The first unit was completed and installed in March of this year, and on the 21st and 22d of April an elaborate test was made by James H. Wise, representing J. G. White & Company, acting hydraulic engineers for the purchaser. The efficiency was found to exceed the guarantees,—the maximum efficiency being 85.5 per cent, and the construction of the other three units was started at once.

Test.

The efficiency test is interesting, as it was made with every possible method of refinement, both on the electrical as well as the hydraulic end.

For measuring the water a permanent weir was built in the tailrace, consisting of two weirs each 9.75 ft. wide and about 10 ft. apart. Two hook gages were used and an average of six readings of each gage was taken for determining the flow of water over the weir. In calculating the water quantity, the Francis formula was used:

$$Q = 3.33\ (b - 0.1\ nH)\ [\ (H + h)^{3/2} - h^{3/2}\ ]$$

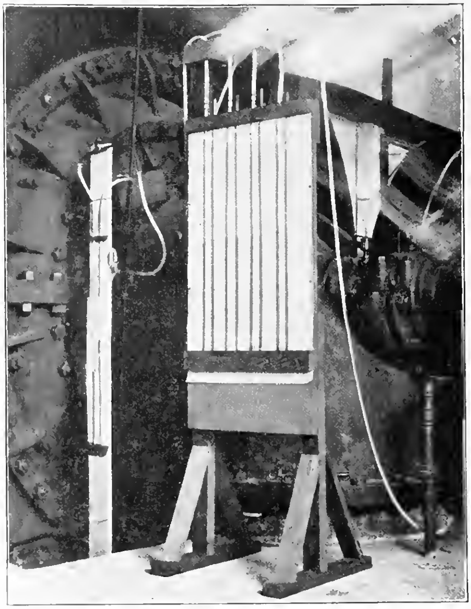
thus allowing for the end contraction and also the velocity of approach at each test.

Baffle boards evenly spaced were set 15 ft. back of the weir crest in order to get a perfectly even flow of water over the weir.

The velocity of approach did not exceed 1 ft. per second at any of the tests. For measuring the pressure head at the turbine, a Bourdon gage was connected to a prizometer ring on the inlet pipe and the average of the pressure at quarter points of the pipe was obtained. The gage was checked (in place) before and after the test with a Crosby dead weight gage tester and the necessary corrections made. The vacuum was measured by means of mercury U tubes at quarter points on the draft tube. The actual distance from center line of shaft to tailrace level was also measured for establishing the draft head which varied from 24 to 22.66 ft.

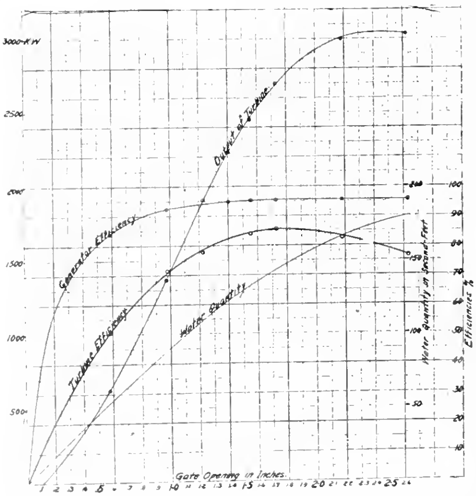
For calculating the input to the turbine, the total effective head was made up of the pressure head in the supply pipe at the turbine plus the velocity head at this point, plus draft head, all corrected to center line of shaft.

The electrical measurements for establishing the generator output and also for determining the efficiency of the generator, were made with indicating



Mercury Vacuum Gauge.

and integrating watt meters. Generator No. 3, the unit under test, was paralleled with the transmission line and partly loaded, but it was found that



Efficiency Test of 4000 H.P. Pelton-Francis Turbine.

its voltage could not be raised above 2000 volts with a unity power factor on the generator. As it was desirable to run the test with as near the normal ter-

Test No.	Time Interval	Head Measurements: Pressure Gage Lbs.*	Head: Correction for Velocity of Approach in Feet	Head: Effective Pressure Head Feet	Head: Draft Head Feet	Head: Total Effective Head	Water Measurements: Average of Hook Gage Readings	Water: Discharge of Over Weir Sec. Ft.	Water: Correction for Velocity of Approach	Water: Total Q Sec. Ft.	Water: Quantity Used by Turbine	Input to Turbine KW.	Generator: Speed RPM	Generator: Frequency Average	Generator: Average Ampere per Phase	Generator: Field Ampere	Generator: Terminal Voltage	Generator: Average of Watt Meter Readings	Generator: Losses Including Copper, Iron, Windage & Friction	Output Turbine KW.	Efficiency	Remarks
0							.2107	6.26	—	6.26	—	—	—	—	—	—	—	—	—	—	—	Exciter and Leakage Water
1	3:10 3:36	103.-	.03	238.22	24.03	262.25	.9678	61.10	.09	61.19	54.43	1217.5	234	50.25	153	120	2216	515.8	101.8	617.6	50.5	
2	3:40 4:16	102.-	3.30	237.31	23.72	261.03	1.2709	92.06	.37	92.43	86.67	1914.9	233.6	50.33	329	120	2190	1267.8	104.2	1372.1	71.7	
3	4:30 4:55	101.95	3.01	237.76	23.40	261.16	1.4904	116.22	.52	116.74	110.40	2441.0	234	50.4	463	127.8	2214	1734.0	112.4	1928.0	78.9	
4	5:10 6:45	101.07	4.00	237.92	23.30	261.26	1.8006	128.02	.64	128.66	122.40	2707.4	234	50.8	587	125	2156	2113.8	114.4	2228.2	82.3	First one foot flashboard placed on overfall spillway raising head water one foot
5	8:00 8:10	100.46	5.49	236.03	23.82	259.85	1.6767	130.33	.80	139.13	132.07	2921.8	233	50.37	609	130	2192	2341.6	119.6	2421.6	82.9	
6	8:20 8:40	100.30	6.31	237.05	22.93	260.40	1.7600	148.71	.95	149.66	143.40	3462.4	233	50.36	657	135	2222	2975.1	128.	2700.1	85.3	Second one foot flashboard placed on overfall spillway raising head water one foot
7	8:55 7:00	99.00	8.00	236.77	22.76	259.53	1.9344	171.11	1.18	172.26	166.00	3647.0	234	50.13	741	136	2214	2862.4	128.9	2991.3	82.1	
8	7:10 7:20	98.-	10.09	235.84	22.66	258.50	2.0390	184.92	1.36	186.30	180.04	3930.2	232	50.6	762	135	2166	2886.2	129.9	3016.1	76.6	

*Pressure gage located .33 ft. below center line of shaft.

Test Results,

minal voltage of 2200 for the generator as possible, generator No. 2 was started up and also paralleled with the transmission line. Then the water of this unit was shut off, allowing it to float on the line; and by over-exciting its field, the transmission voltage was raised, so that the generator under test could be run at practically nominal voltage. All the other generators were shut down during the entire test.

As all the generators of this power station operate with the neutral point of the armature winding

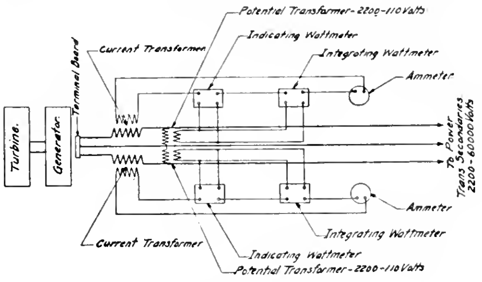


DIAGRAM OF CONNECTIONS FOR TEST ON GENERATOR #3

grounded, this ground connection was cut off during the test in order to prevent the possibility of any power being exchanged through this neutral and the third leg, which does not pass through the watt meters.

Efficiency Test of Generator.

Immediately after the full load test was made, the generator was shut down and the armature resistance taken while the copper was still hot. The "drop of potential" method was used for this. In order to determine the iron loss and the friction and windage losses, both generators Nos. 2 and 3 were put on the transmission line and then the water shut off generator No. 3 and both generators cut loose from the transmission line. In this way the generator under test was run as a synchronous motor and was now given an increased field excitation for each point of the test. The voltage of the driving generator was varied so as to give a unity power factor input to the synchronous motor. Generator No. 2, the driving machine, was held at 50 cycles by the man operating the turbine gates, he having a frequency meter at his post. From the test curve it will be seen that the maximum efficiency of the generators ran as high as 95.7 per cent for full overload and 92 per cent at half load.

The accompanying test results are self-explanatory and interesting, as they prove that a reaction turbine can give excellent results and high efficiencies under extremely unfavorable conditions, where even impulse wheels have been considered.

The hydraulic end of the test was handled by James Wise, now assistant general manager of the Pacific Gas & Electric Company, and Mr. Jos. Mini, Jr., had charge of the electrical end. Present also during the test was Mr. Woodbury from the Pacific Light & Power Company of Los Angeles.

IDAHO CEDARMEN ADOPT STANDARD LIST OF WEIGHTS OF POLES.

The Idaho Cedarmen's Association met November 7, in Spokane, at the call of President Lindsley. Several matters of interest were taken up and considered, among them the adoption of a standard list of weights of poles. A committee on publicity was appointed by the president, consisting of J. C. Davis, of the Humbird Lumber Company; H. C. Culver, of the Sand Point Lumber & Pole Company, and R. L. Bayne, of the Lindsley Brothers Company, to look into the matter of securing a greater publicity for the merits of the western cedar poles. An early issue of the Journal of Electricity, Power & Gas will contain the results of a series of careful tests on the strength of poles recently conducted by the Pacific Telephone & Telegraph Company, which show the superiority of western over eastern cedar.

STANDARD BOILER RULES.

Standard rules for the care and construction of boilers are to be made the subject of study by a special committee appointed by the American Society of Mechanical Engineers. There is reason to believe that a set of carefully prepared specifications formulated and recommended by such a committee will be recognized as a standard by legislatures and officials, and that uniformity in legal provisions will be obtained.

BREAKING OF SNOW BLOCKADES IN NORTHWEST.

That the single-phase systems is inherently fitted for electric railways is well illustrated by some experiences that the Spokane and Inland Railroad Company, which operates a 11,000 volt, single-phase line in the State of Washington, has had during the last two years.

It has been found that during the winter when the steam trains, operating on routes paralleling that of the single-phase, are unable to get through without considerable delay, single-phase trains hold very closely to their schedules. The principal reason for this is that on a single-phase road the voltage is so high that it holds up to almost normal even when the motors on the locomotives or cars are drawing very heavy currents. Upon an ordinary 600 volt road when the cars must "buck" snow, the current consumption is so great that the line voltages usually drop to a value too low for effective operation. On a steam road the ability of a steam locomotive to haul loads is actually reduced in cold weather because of the greater losses of heat from the locomotive. The reverse is true with an electric locomotive because in cold weather the motors are maintained at a much lower temperature than in warm weather, hence their ratings are increased.

As indicated in the illustration the only plough used on the Spokane and Inland trains was one of the usual shield type mounted on the pilot. This has proven to be entirely effectual in keeping the line clear enough of snow for satisfactory single-phase operation.

The winter of 1909 and 1910 was one of the most severe ever experienced in that vicinity. The Spokane and Inland was the only local road that maintained its regular scheduled service through this trying winter. At no time during the worst storms was the Spokane and Inland trains more than 20 minutes behind its schedule. This excellent showing was maintained even when there was a foot or more of snow on the ground and six to ten feet of it in cuts. No regular snow plough is used on the Spokane and Inland lines.

The illustration shows a train just after arriving in Spokane 20 minutes late after riding through a storm that completely tied up all the steam roads in the vicinity. The Spokane and Inland motor car shown in the illustration is equipped with four No. 132 Westinghouse single-phase motors and Westinghouse HB control.

Electric Train Arriving in Spokane When All Steam Roads Were Tied Up.

BIDS FOR ELECTRIC CARS.

Bids for constructing 43 cars of the pay-as-you-enter type for the Geary-Street municipal railroad were opened Wednesday by the Board of Public Works. Separate proposals for all-steel and semi-steel cars were asked. Only one bid was received for all-steel cars. It came from the Pierson-Roeding Co., representing J. G. Brill & Co., of Philadelphia, these manufacturers offering to furnish such cars for $9600 each. Their bid for semi-steel cars was $7950 each. The other bids for semi-steel cars were: W. L. Holman & Co. of San Francisco, $7393 each; McGuire-Cummings Mfg. Co. of Chicago, $7145 each; Jewett Car Co. of Newark, O., $6554 each. The lowest bid, that of the Jewett Car Co. of Ohio, amounted to $287,222 for cars and extra trucks. That of the San Francisco car manufacturing concern, the Holman company, was $50,000 greater, aggregating $337,222. The other totals were: McGuire-Cummings Co. $312,635; Pierson-Roeding Co. $419,300 for all-steel and $348,350 for semi-steel. The award of the contract was deferred until next Wednesday.

SIMPLE LAWS OF EXPANSION.[1]

BY ROBERT SIBLEY.

We come now to a consideration of the laws of expansion of perfect gases touched upon in the fifth lecture of this series. It will be recalled we found that in a so-called perfect gas the pressure, volume, and temperature are always related, as expressed in the following equation:

$$pv = RT \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which p is the pressure in lb. per sq. ft., v the volume of one lb. expressed in cubic ft., T is the absolute temperature in Fahrenheit degrees, and R is a constant for each particular gas, having a value of 53.37 for air.

Since we are now about to enter upon a discussion of methods of computing power in various steam, air, and other gas engines, it is necessary for us not only to thoroughly understand this relationship, but also some of the laws of expansion met with in engineering applications.

We have defined specific heat in previous lectures as being the quantity of heat necessary to raise one lb. of a substance one degree in temperature. In the case of gases, however, we find that in general a gas has two specific heats. The specific heat at constant volume, C_v, is the quantity of heat necessary to raise the gas one degree in temperature, the volume remaining the same. For air this quantity of heat is 0.17 B.t.u. or 132 ft. lb. The specific heat at constant pressure C_p, is the quantity of heat necessary to raise the gas one degree in temperature, the pressure remaining constant and the volume expanding to accommodate the new conditions. For air this quantity of heat is 0.239 B.t.u., or 186 ft. lb.

It is evident, then, that heat is utilized for something else than actually raising the temperature, and this something else is exactly what we desire to look into, for, as engineers, we find it has the most useful applications. As engineers we are interested in anything that can do work. We define work as a product of a force and the distance through which the force acts. Thus in a steam engine the total force in lb. acting on the piston head multiplied by the stroke in ft. gives us at once the ft. lb. of work done each stroke. If then P is the pressure in lb. per sq. in. and A is the area of the piston head in sq. in., the total force is PA lb., and if this force acts through a distance of L ft., the same being the so-called stroke of the engine, the work done is PLA ft. lb. per stroke. Again, if there are N strokes per minute the total ft. lb. of work per min. are PLAN. Now we define one horsepower as work at the rate of 33,000 ft. lb. per min. Hence the horsepower in any engine is at once

$$\text{H.P.} = \frac{\text{PLAN}}{33{,}000} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

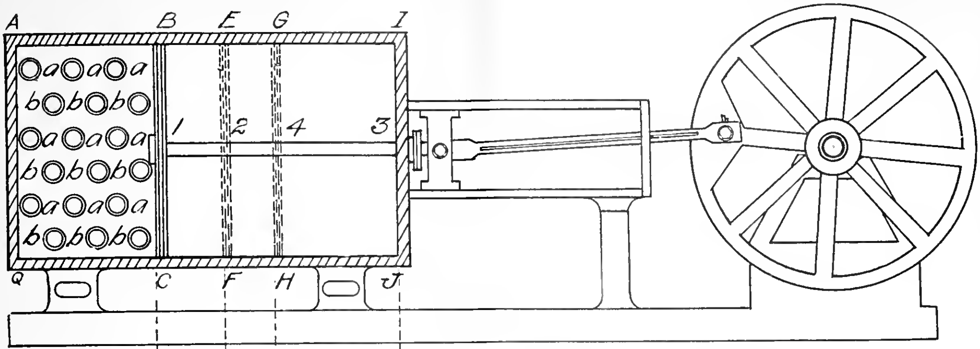
We are interested in computing the particular value of P to substitute in the above formula. It is evident in any given case that the pressure will be different at different parts of the stroke. Hence in the succeeding lectures we shall devote considerable attention to methods of computing an average for P, or, in other words, such a value that we can substitute directly in our formula above and accomplish exactly the same results we would otherwise accomplish by taking the instantaneous values of the pressure at different parts of the stroke.

When heat is supplied to a gas, this energy in general performs two functions. Part of the energy goes toward raising the temperature and the remainder toward performing work. Hence the thermodynamic efficiency of a heat engine is always at once computed by taking the ratio of the actual work done by the gas to the total heat energy supplied. In order to make a gas expand or compress at our pleasure, we must have means of supplying heat and drawing it off at proper intervals. A regulation of the pressure, too, must also be under our control.

Let us suppose that we have in the cylinder in Fig. 28, 10 units of air by volume and that the air is under 10 units of pressure. This, plotted to scale below, is shown at 1 in the pressure-volume diagram. Now by means of pipes a a . . . let us admit heat in sufficient quantity to cause the air to expand and at the same time raise the temperature of the air. The piston head shown at B C will be pushed forward to E F. Let us suppose that the line 1-2 correctly represents the volume and pressure at any point during this movement. At the point E F, let us now manipulate the cooling pipes bb . . . in such a manner that as the air still further expands to I J, the temperature is reduced and the pressure falls off so that the line 2-3 correctly represents the pressure and volume at any position of the piston head. On the return stroke, as the piston moves from I J to G H, the pipes a and b are manipulated so that proper quantities of heat are supplied or drawn off to make 3-4 represent the pressure and volume in a law similar to the expansion from 1 to 2 and the point 4 is at such a place that when the piston head completes its stroke from G H to B C heat is supplied, or drawn off on a similar law to that from E F to I J so that the compression curve 4-1 is similar to the curve 2-3 and exactly closes at 1. Such a series of operations is known as a cycle and depending upon the particular nature of its composing curves has very important applications in heat and gas engines of all kinds.

Now as the piston in the above figure was forced to move from B C to E F, it is evident that it was necessary to supply heat in sufficient quantity to raise the temperature of the gas from that at 1 to the temperature at 2. Since C_v heat units are necessary to raise the temperature of the gas one degree, to raise it $(T_2 - T_1)$ degrees requires $C_v \; (T_2 - T_1)$ B.t.u. But heat is also required to do external work in shoving the piston ahead. We have seen that work is the product of a force or pressure and the distance past through. By looking at the diagram, this pressure is evidently variable. Take a small distance u v as shown in the diagram, in fact so small that the pressure is constant over this distance, and evidently the work done is $p \times u\,v$. If now I divide the entire diagram into similar small distances and scale off the corresponding pressures, I can form a series of these products of small distances and pressures corresponding

[1] This paper comprises the Twelfth Lecture of the series appearing in these columns entitled "Primer of Applied Thermodynamics," which is a resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Mechanical Engineering students at the University of California.



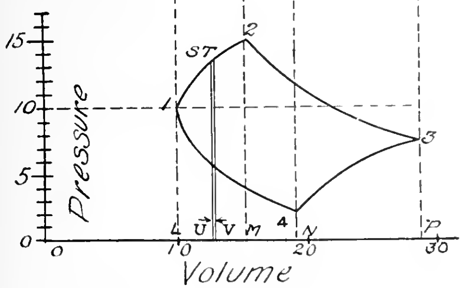


Fig. 28. Diagramatic Representation of a Heat Engine.

to each particular small distance. Since the bore of our cylinder creates a constant increase in volume as the piston head moves forward this distance is evidently proportioned to the volume and it is also evident that the work done and computed by adding the small products above referred to, is the area 1 2 M L as shown in the diagram. Hence, if I simply take a planimeter and measure this area or if I compute the area by any other method I compute at once the work done. Hence we have the important expression

$$Q = C_v (T_2 - T_1) + \text{Area } 1\,2\,M\,L \quad . \quad . \quad . \quad . \quad (3)$$

in which Q is the heat supplied and is all accounted for in the right hand side of the equation; namely, a portion used in heating the gas and the remainder in doing external work.

As hinted at previously in these lectures the expansion of gases seems to obey expoential laws. The general law of expansion is assumed to form

$$pv^n = K \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

in which n and K are constants and can be determined when a series of values for p and v are taken by experiment in any given case.

Having now assumed that our law of expansion is of the form $pv^n = K$, we need only to compute the value of n from experimental data as illustrated in the lecture on How to Determine Empirical Formulas and we find we can at once compute the work the gas will do under given conditions and also the temperature, pressure, and volume relations. From methods of integral calculus, we can now derive a numerical value for the area 12 M L shown in equation 3, which depend solely upon this value n. We find in this higher realm of reasoning that area 1 2 M L is equal to

$$\frac{R}{1-n}(T_2 - T_1)$$

Hence we have at once

$$Q = C_v (T_2 - T_1) + \frac{R}{1-n}(T_2 - T_1) \quad . \quad . \quad . \quad . \quad (5)$$

as a most important thermodynamic law. Interpreted in words this law means that if I supply Q B.t.u. to a perfect gas which expands according to the law $pv^n = K$, a part of this heat will go toward raising the temperature of this gas and will be in amount $C_v (T_2 - T_1)$ B.t.u. The remainder of the heat supplied will go toward doing external work and will be in amount $\frac{R}{1-n}(T_2 - T_1)$ ft lb. It is important to note that the former is expressed in B.t.u. while the latter quantity in the right hand side of this equation is expressed in ft. lb. of energy.

From this one equation we can deduce important results for particular values of n. Thus, aside from the general law of expansion we often desire to study the relations between heat supplied, rise in temperature and work done when heat is supplied and the gas remains under constant pressure, constant volume, or constant temperature. Again, a most important relationship is that known as adiabatic expansion. This expansion takes place when the gas expands without heat being added or taken away, the gas simply doing external work by calling on its internal reservoir of energy by virtue of its temperature above absolute zero. Let us for a moment look into these relations:

1. When n = 0, we have $pv^0 = K$, or $p = K$.

This means that since the pressure is always equal to a constant the gas expands under constant pressure.

We have seen from equation 5 that the work done is expressed as follows:

$$W = \frac{R}{1-n}(T_2 - T_1)$$

Hence for constant pressure

$$W = \frac{R}{1-0}(T_2 - T_1) = R\,(T_2 - T_1)$$

Also $Q = C_v (T_2 - T_1) + \frac{R}{1-n}(T_2 - T_1)$

$$= C_v (T_2 - T_1) + R (T_2 - T_1)$$

We have previously defined C_p as being the quantity of heat supplied to raise a lb. of gas one degree in temperature. Then to raise a gas $(T_2 - T_1)$ degrees will rquire $C_p (T_2 - T_1)$ B.t.u. Substituting in our equation above we have, for constant pressure

$$Q = C_p (T_2 - T_1)$$

$$\text{Or } C_p (T_2 - T_1) = C_v (T_2 - T_1) + R (T_2 - T_1)$$

$$\therefore C_p = C_v + R$$

Hitherto we have considered this quantity R as a meaningless constant. We now see that it is the amount of work done to raise a gas one degree in temperature when expanding under constant pressure. Hence if we know the specific heat of a gas under constant volume we can at once compute its specific heat for constant pressure.

2. When $n = 1$, we have $pv^1 = K$ or simply that the product of pressure and volume is always a constant. But from equation 1, we know that $pv = RT$, hence T must be a constant. This is known as isothermal expansion. The work in this case is

$$W = \frac{R}{1-n} (T_2 - T_1) = \frac{R}{1-1} (0) = \frac{R\,0}{0} = \frac{0}{0}$$

This is an indeterminate quantity and only by calculus can its true value be ascertained. By this method

$$W = p_1 v_1 \log_e \frac{v_2}{v_1}$$

Hence the special form of equation 5 for this case is

$$Q = C_v (T_2 - T_1) + \frac{R}{1-n} (T_2 - T_1)$$

$$= p_1 v_1 \log_e \frac{v_2}{v_1}$$

It is evident then that all of the heat supplied goes toward doing external work which is most important from an engineering standpoint.

3. When $n = \dfrac{C_p}{C_v}$ or 1.41 in case of air, we have $pv^{C_p} = K$. Substituting in equation 5 we have

$$Q = C_v (T_2 - T_1) + \frac{R}{1-n} (T_2 - T_1)$$

$$= C_v (T_2 - T_1) + \frac{R}{1 - \dfrac{C_p}{C_v}} (T_2 - T_1)$$

$$= C_v (T_2 - T_1) + \frac{R\,C_v}{C_v - C_p} (T_2 - T_1)$$

$$\text{But } C_v - C_p = -R$$

$$\therefore Q = C_v (T_2 - T_1) - C_v (T_2 - T_1) = 0$$

When $n = \dfrac{C_p}{C_v}$, we see then, that the gas expands from its internal energy alone as no heat is supplied. Under this case of expansion we have

$$C_v (T_2 - T_1) = \frac{R}{1-n} (T_2 - T_1)$$

4. When $n = \dfrac{1}{0}$ or in other words when n has an infinitely large value, we have

$$pv^n = K$$

$$p^{1/n}\, v = K^{1/n}$$

$$\text{Substituting } n = \frac{1}{0} \quad p^0 v = K^0 \quad \text{or } v = 1$$

Hence in this case the volume remains equal to unity or no expansion takes place at all. In other words the external work is zero for

$$W = \frac{R}{1-n} (T_2 - T_1) = 0$$

and all the heat supplied goes toward raising the temperature of the gas and is equal to

$$Q = C_v (T_2 - T_1)$$

Such fundamental equations as are discussed in this lecture have most important applications. In nearly every computation involving gas or steam engine design some one of these equations must be taken into account. The student, then, should thoroughly familiarize himself with them and see if he can solve such problems as are contained in the following Thermotwisters.

Thermotwisters.

1. If 50 B.t.u. are added to 6 lb. of air having a pressure of 30 lb. per sq. in. and a volume of 35 cu. ft., what is the final v, p, t and the work done?

(a) When the heat is supplied and expansion takes place at constant pressure.

(b) When the heat is supplied and expansion takes place at constant temperature.

(c) When the heat is supplied and the volume remains constant.

(d) When the heat is supplied and the expansion follows the law $pv^{0.6} = K$.

2. The above air expands adiabatically until the final volume is 70 cu. ft., what is the final p, t and the work done?

SOLUTION OF THERMOTWISTERS, TENTH LECTURE.

1. Allowing for an efficiency of 75 per cent, what is the power required to drive a mechanical draft fan with a rounded-off conical mouthpiece 7 in. in diameter which delivers air at 2 oz. pressure with a velocity of 86 ft. per sec.?

On page 425, we find theoretic power in ft. lb. per sec.:

$$P = av \times \frac{v^2 d}{2g} \qquad \text{Also } p = \frac{v^2 d}{2g}$$

$$\therefore P = p\,a\,v$$

where $p = 2/16$ lb., since coefficient of contraction $= 0.98$,

$$a = .98 \frac{d^2}{4} = .98 \times .7854 \left(\frac{7}{12}\right)^2, \quad v = 86$$

∴ Horsepower taking account of efficiency

$$= \frac{2}{16} \times .98 \times .7854 \times \frac{49}{144} \times \frac{86}{.75 \times 550} = .0034. \quad \text{Ans.}$$

2. If the diameter of the above fan is 27 in., what is the number of revs. per min. it undergoes?

In one rev., perimeter of wheel travels $\pi \times d$ ft.

$$\therefore \text{No. of revs. per sec.} = \frac{86}{\pi d} = \frac{86 \times 12}{3.1416 \times 7} = 4.7.$$

$$\therefore \text{revs. per min.} = 60 \times 4.7 = 282. \quad \text{Ans.}$$

3. Air is driven through a pipe 12 in. in diam. 2000 ft. long. The difference in pressure between the two ends is 4 oz. How many lb. of air are delivered per min. and what is the velocity of the air and the horsepower required?

To compute D, assume ordinary atmospheric conditions of pressure of 14.7 lb. per sq. in. and temperature of 65° F. Hence $p = 14.7 \times 144$, $R = 53.37$, $T = 459.4 + 65 = 524.4$.

$$pv = RT, \text{ but since } D = \frac{1}{v} \text{ we have}$$

$$\therefore D = \frac{p}{RT} = \frac{14.7 \times 144}{53.37 \times 524.4} = .0757$$

$$\therefore W = 64 \left(\frac{0.25 \times 0.0757}{4.6 \times 2000} \right)^{1/2} = .00919 \text{ lb. per min. Ans.}$$

SOLUTION OF THERMOTWISTERS, NINTH LECTURE.

3. The above power plant is located at an altitude of 5000 ft. above sea-level and crude petroleum is to be burned. What are the proper dimensions?

For crude petroleum a proper height is 100 ft. From Kent's tables I find on page 398 no data for 2000 horsepower at 100 ft. height. Hence I substitute in formula

$$H.\ P. = 3.33 \left(A - 0.6 \sqrt{A}\right) \sqrt{H}$$

$$2000 = 3.33 \left(A - 0.6 \sqrt{A}\right) 10$$

$$\text{or } A - 0.6 \sqrt{A}$$

I first try $A = 66$ and find this almost solves equation. I next substitute $A = 65$ and find equation reduces to zero. Since for crude petroleum, we require but ½ the area, our stack should have an area of 32.5 sq. in. or an inner diameter of 6.43 ft. or 77 inches.

Since, however, our plant is at an altitude of 5000 ft. above sea, I find that this corresponds to a barometric reading of 24.8 inches as compared with 30 inches at sea-level.

$$\text{Hence } r = \frac{30}{24.8}$$

$$H_1 = r\,H = \frac{30}{24.5} \times 100 = 122.5 \text{ ft. Ans.}$$

$$d_1 = r^{2/5} d = \left(\frac{30}{24.5}\right)^{2/5} \times 77 = 1.08 \times 77 = 83 \text{ ins. Ans.}$$

CLEVER ADVERTISING IN LOS ANGELES.

Below are some samples of the advertisements which the Southern California Edison Company flashed on the Auto-Racing Display device on South Broadway in Los Angeles.

They are designed to impress upon the public the advantages of electric signs over all other kinds of signs.

NIGHT SIGNS BRING DAY BUSINESS.
A PAINTED SIGN QUITS AT DUSK.
WRITE NIGHT LETTERS TO BUYERS.
CAN YOU SEE THE PAINTED SIGNS?
OUTLINE YOUR STORE WITH LIGHT.
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CENSUS STATISTICS ON GAS, ILLUMINATING AND HEATING.

The general summary shows increases in all the items at the census of 1909, as compared with that for 1904, except for miscellaneous expenses, which decreased 6 per cent.

The number of establishments increased 27 per cent; capital invested, 26 per cent; the gross value of products, 33 per cent; cost of materials, 41 per cent; value added by manufacture, 30 per cent; average number of wage earners employed during the year, 22 per cent; amount paid for wages, 23 per cent; number of salaried officials and clerks, 44 per cent; amount paid in salaries, 46 per cent; primary horsepower, 76 per cent.

There were 1296 manufacturing establishments in 1909 and 1,019 in 1904, an increase of 27 per cent.

The capital invested as reported in 1909 was $915,537,000, a gain of $190,502,000, or 26 per cent, over $725,035,000 in 1904. The average capital per establishment was approximately $706,000 in 1909 and $712,000 in 1904.

A general summary appears in the following tabulation:

GAS, ILLUMINATING AND HEATING—GENERAL SUMMARY: 1909 AND 1904.

	Census— 1909	Census— 1904	Per cent of increase, 1904-1909.
Number of establishments	1,296	1,019	27
Capital	$915,537,000	$725,035,000	26
Cost of materials used	$52,428,000	$37,180,000	41
Salaries and wages	$33,316,000	$25,522,000	31
Salaries	$12,385,000	$8,464,000	46
Wages	$20,931,000	$17,058,000	23
Miscellaneous expenses	$27,757,000	$29,557,000	[1] 6
Value of products	$166,814,000	$125,145,000	33
Value added by manufacture (products less cost of materials)	$114,386,000	$87,965,000	30
Employees			
Number of salaried officials and clerks	13,515	9,406	44
Average number of wage earners employed during the year	37,215	30,566	22
Primary horsepower	128,350	73,101	76

[1] Decrease.

GAS, ILLUMINATING AND HEATING—PRODUCTS BY KIND AND QUANTITY: 1909 AND 1904.

		Census— 1909	Census— 1904	Per cent of increase, 1904-1909.
Gas, cubic feet	thousands	[1] 150,835,793	112,549,979	34
Straight coal		[1] 19,985,253	12,093,034	57
Straight water		1,726,082	715,550	141
Carbureted water		79,418,486	54,687,418	45
Mixed coal and water		40,775,283	40,980,414	[2] 1
Oil		8,688,860	3,441,352	152
Acetylene		[1] 25,186	7,881	220
All other		216,043	24,330	790
Coke	bushels	[1] 82,049,683	89,146,434	[2] 8
Tar	gallons	[1] 92,152,938	67,515,421	36

[1] In addition, in 1909, 27,558 thousand cubic feet of straight coal gas, 13,070 thousand cubic feet of acetylene gas, 44,347 bushels of coke, and 38,370 gallons of tar were produced by establishments engaged primarily in the manufacture of other products.
[2] Decrease.

The Auto-Racing Electric Display in Los Angeles.

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Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

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CONTENTS

Irrigation Ventures

Undoubtedly the irrigation project, founded on sound engineering principles, constitutes one of the safest investments open to capital. By means of it, worthless land is transferred into a living tangible asset. No more weird spectacle can be imagined than the bleak howling wilderness of sagebrush and desolation that constitute the arid lands of the West and yet how beautiful, how heavenly transformed become these identical lands under scientific irrigation and cultivation. The clear, wholesome morning air re-echoes in the sound of children's voices the blessings of health and happiness such projects repay to the nation.

During recent years the money markets have been stirred through and through in the financing of western irrigation projects. The earlier undertakings were successful from the start because the idea was new, the projects few, and the proposed irrigation scheme of simple operation. In recent years, however, projects involving acreages by millions have had a tendency to glut the market, not so much by the overdoing of the irrigation side as the non-education of prospective settlers.

The irrigation promoter of today must be alive to the fact that to make a project successful, the settler must be successful. The settler must be educated properly to handle his apple orchard with the same thrift and industry he sold magazines in his little stationery store in the heart of Chicago. This idea of coming out West to fish and hunt, while the apples mysteriously roll into the boxes, cart themselves to an eastern market, bringing six dollars a box is a forceful illustration of "Danny's" dream. The fundamental reasoning is sound and sane, however, as is testified to by thousands of happy settlers in the West.

Education and hard systematic study of conditions is the only ultimate solution. Our western water powers stand ready to pump water for millions of acres of arid lands not now available. Let us beware and see to it that the settler remains happy and contented for a happy contented settler is the biggest blessing possible to a successful enterprise and to the State.

A Clearing House For Trouble

It was a beautiful myth enjoyed by the ancient Greeks that no trouble was known to the world until Pandora was given the now famous mysteriously sealed box and womanlike, possessed of an uncontrollable curiosity to view its inner contents, she one day opened the lid only to find that she had liberated countless spirits of trouble to ever after plague mankind. Whether or not she realized the bickerings, the jealousies, the untold sufferings she was thus bringing to human beings is of little concern. The fact remains that ever since she thus pried the lid off, trouble has been among us.

In the every day run of human business affairs numberless misunderstandings arise. It makes little difference whether or not we as a matter of fact actually wronged a man, if he thinks we have wronged him the harm is done just the same.

And so it is in affairs electrical. In the busy run

of life the central station man ever planning and working to broaden and deepen his field of activity at times seemingly treads upon territory rightfully owned by the jobber or the contractor. The contractor in his feverish endeavors to increase his own influence drives contracts and purchases his supplies in ways which bring forth criticism from the jobber or the retailer and even the one who finally saddles the whole cost of electrical power and supplies, the consumer, has at times, it must be admitted by all, a rightful demand to call for at least the respect and consideration due a member of the vertebrate family of organisms.

Every living thing travels. Many smaller animals in their wanderings encircle the globe. Rats do. Troubles, like living organisms, seemingly are in a perpetual state of agitation. They spread as rapidly as a school-girl's secret.

Some weeks ago the Journal, with the assistance of others direct from the firing line, invited a few of the jobbers, the central station men, the contractors, the manufacturers, the retailers, and engineers, to a get-together-luncheon at the Palace Hotel in San Francisco to meet Philip S. Dodd, secretary of the National Electric Light Association, and incidentally talk over the betterment of the mutual relations of all concerned. The project has met with unanimous support from all quarters. A strong realization is felt that after all a mutual interchange of ideas and friendly criticisms in a clearing-house for trouble, such as proposed by the men present would result in the unquestioned betterment of all concerned.

It is surprising what a straightforward man-to-man talk can do on such occasions as this. A perfect team work among conflicting interests is secured and such harmony generally brings from the ever-watching public an increased patronage.

A meeting is called for the 28th of November in San Francisco at which time ideas will be presented involving a permanent organization with monthly meetings for all those in any way interested in electrical affairs. The committee has in view the annihilation of the social side as far as possible, although the monthly meetings will be held around the festive board of some of the city restaurants. The whole idea pervading those interested in the movement is to forward the electrical interests on the Coast by open, clear, frank expressions as to how mutual cooperation of all concerned can be best obtained.

The idea suggests at once similar gatherings in the other electrical centers on the Coast. Spokane, Seattle, Portland, Los Angeles and the other distinct distributing groups on the Coast would do well to promulgate similar meetings of cooperation, within their fields of activity. Undoubtedly the idea is not entirely new, for in the past the jobber, the central station man, the retailer, the manufacturer, and the engineer have all had their separate organizations, but never has there been this proposed dovetailing of divergent interests for the common good. More earnest endeavors, candid and friendly criticisms, and talks of the kind that touch the heart-strings of men, will do worlds of good in furthering electrical development on the Coast.

And Why Not?

Each year the civilized world is startled and yet fascinated by reading the pranks and fantasies of the famous gridiron club at Washington in annual banquet assembled. Many of the most potent electrical men of the Coast are about to form, as stated above, an organization in San Francisco to promote the welfare of all those interested in matters electrical within the sphere of their influence. It is proposed that the meetings be serious and earnest, avoiding as far as possible the social side of gatherings of this nature. The idea is excellent and much good cannot help but follow. The particular group in question, illustrative of the spirit of good fellowship known only to those engaged in electrical matters, must have some means, however, of opening up a circuit breaker at the proper intervals when running under such heavy loads as will be occasioned from time to time in the serious discussions anticipated.

Since the days when early Spanish settlers named the great golden gate city after their religious patron, Saint Francis, the very name itself has so entered the hearts of the thousands throughout the world who have at one time or another been guests of this western metropolis but one and only one solution can be offered as a condenser to absorb the enormous charging current created by these serious gatherings—and that is, once a year, to hold at San Francisco an electrical high jinks in the way of a unique electrical dinner.

San Francisco is unique among cities in her method of handling her dignified banquets at the Palace or St. Francis, her spicy evening dinners at the Techau, the Poodle-dog or Taits, and even her love feasts at breezy Sanguinetti's on a Saturday night. In this new venture, however, something entirely different is suggested. It is suggested to make it a gathering to which electrical men of the Coast be invited, and that the features of the evening be as novel and unique as the advance of the electrical profession will allow. In a word that such toasts which the committee in charge think best to be given during the evening be interspersed with electrical surprises, novelties and stunts, so that Bill Jones will go home ready to take a new lease on life for the serious duties of the next year, and also so that he will go home with a more wholesome reality of the true worth and genuine friendship of his fellows engaged in the upbuilding of a great Western electrical empire.

But three such annual occurrences can possibly take place before the arrival of the year of years when the proposed international electrical congress will be held at San Francisco during the Panama-Pacific International Exposition. It is an old saying that there is luck in odd numbers, if so, let us all improve these three preliminary "try-outs" to the very best possible advantage and in the fourth let us have an electrical high jinks and banquet that will demonstrate to the entire electrical world the sterling composition of the men who in the West in affairs electrical, stand for all that is true, all that is earnest and all that is progressive.

So here's for the electrical banquet: Please pass the electric currents!!

PERSONALS.

J. W. White of the sales department of the Fort Wayne Electric Works, is at Los Angeles on business.

F. W. Loomis, illuminating engineer with the Holophane Company, spent the past week at Los Angeles.

A. K. Detweiler, of Detroit, who is interested in the Home Telephone Company, is at San Francisco.

W. W. Briggs, assistant sales manager of the Westinghouse Electric & Mfg. Co. has returned to San Francisco from the East

George Cross, western manager for the Humphrey Water Heater Company, of Kalamazoo, Michigan, is at Los Angeles.

H. E. Sanderson, manager of the Bryant Electric Company's Pacific Coast branch, has returned to San Francisco from Monterey.

E. V. D. Johnson, general manager of the Northern California Power Company, with headquarters at Redding, is at San Francisco.

H. M. Cooper, who is connected with the Pacific Gas & Electric Company, headquarters at Auburn, is a recent arrival at San Francisco.

H. E. Eisenmenger is making a trip throughout the Pacific Coast in the interests of the National Electric Lamp Association of Cleveland.

George W. Bacon, president of the Sierra & San Francisco Power Company, is at San Francisco, conferring with President Calhoun and others.

W. R. Alberger, vice-president of the United Properties Company, returned to Oakland during the past week, after spending a number of weeks in the East.

J. F. Poindexter, a district manager of the Pacific Gas & Electric Company, with headquarters at Marysville, has been spending a few days at San Francisco.

R. D. Holabird, president of the Holabird-Reynolds Electric Company, returned to San Francisco, during the past week, after an extensive eastern tour, and left later for Los Angeles.

George Scaife, of the Pacific Gas & Electric Company, is said to have been a forceful speaker at the second annual dinner of the Grass Valley (Cal.) Chamber of Commerce during October.

P. H. Ridgeway, formerly with the Electric Engineering Company of Seattle, has opened offices at 709 Central Building, Seattle, and will continue to undertake consulting and construction engineering.

H L. Dougherty, of J. G. White & Co.'s engineering staff, who was superintending the construction of the San Joaquin Light & Power Corporation's nyroelectric plant in Crane Valley, has just gone East on a short vacation trip.

E. G. Williams, general manager of construction for J. G. White & Co., of New York, is making an inspection tour of the California plants installed under the firm's supervision, in company with H. A. Lardner, the Pacific Coast manager.

Frank C. Bates, senior member of Bates & Clark, hydraulic engineers and contractors of Seattle, returned recently from a two months' visit to his old home in Wisconsin. Mr. Bates has an attractive mountain orchard home in the Bitter Root Valley, Montana.

A. G. Jones, superintendent of the General Electric Company's motor sales department at San Francisco, who recently returned to San Francisco from the East, was operated upon for appendicitis last Wednesday at the Lane Hospital and is making a rapid recovery.

Theodore N. Vail, who is at the head of the American Bell Telephone Company and president of the Western Union Telegraph Company, is at Los Angeles, where his presence has given rise to rumors that additional independent telephone companies are likely to be absorbed.

E. W. Rollins, head of E. H. Rollins & Sons, is expected to arrive at San Francisco this week with Richard B. Young, who is vice-president of the above firm and a director in the Great Western Power Company.

J. B. Potter, general superintendent of the Oakland Railways, has returned to Oakland after spending a number of weeks in the East inspecting the principal electric railway lines, power plants and factories. His observations will be utilized in the improvement of the Key Route and Oakland traction systems.

H. P. Wilson of New York, who is prominent in the financial councils of the Great Western Power Company, is at San Francisco after inspecting the company's hydroelectric plant at Las Plumas and the site of the new dam at Big Meadows. He was accompanied by Richard Young and Anson W Burchard, both Great Western directors.

Mason B. Starring, the new president of the United Railways Investment Company, is at San Francisco looking over the United Railroads system, with James H. Reed and Patrick Calhoun. Starring has expressed himself as very favorably impressed with both the street car system and the rebuilt city. He is well known in connection with electric railways in Chicago.

Philip Aaron, manager of the Western Electric Company's Seattle branch; C. R. Dedrick, head of the Dedrick Electric Supply Company, of Portland, and E. J. Dwyer, manager of the Holabird Electric Company, of Seattle, composed a group of electrical men who stopped over a few days at San Francisco, after attending the jobbers meeting at Del Monte, and then proceeded north during the past week.

Glenn C. Webster, manager of the engineering department of the National Electric Lamp Association, Cleveland, started Friday, November 17th, on an extended western trip. On Friday afternoon he gave an address on the "Value of Co-operation in Modern Business Enterprises" at the banquet of the National Cloak and Skirt Manufacturers' Association, at Toledo. He is now on his way to Los Angeles, where he will have general oversight of the National Electric Lamp Association's exhibit at the Electrical Exposition. Mr. Webster expects to make a study of industrial conditions in San Francisco and other Coast cities, returning to Cleveland late in December.

EXHIBIT OF THE NATIONAL ELECTRIC LAMP ASSOCIATION AT LOS ANGELES ELECTRICAL EXPOSITION, NOVEMBER 25TH TO DECEMBER 9TH.

The National Electric Lamp Association's exhibit is located near the center of the building in booths 75 and 76.

Most prominent among the various pieces showing incandescent lamps is the "Holophane tree." This is a large tree shaped fixture finished in statuary bronze on which are shown Mazda-Holophane units of six different sizes, the whole being surmounted by a 500-watt lamp. The circuits are controlled by a flasher which lights the different tiers of lamps successively.

A great variety of miniature and low-voltage lamps with drawn wire filaments are shown in a glass case, while lamps designed for automobile use are displayed in modern headlights, side lights, etc. A full line of multiple lamps is on exhibition in a case lighted with Mazda 5-watt sign lamps. The floral decorations of the booth are supplemented by decorative lamps in the shapes of flowers, fruits, animals, etc., especially suited for Christmas tree lighting.

The exhibit is in charge of Mr. F. J. Blaschke. Mr. G. C. Webster, manager of the engineering department, is also in attendance at the booth.

ELECTRICAL CONTRACTORS' NOTES.

George Duffield, special representative of the National Electrical Contractors' Association, is making an extensive trip throughout the Pacific Coast. Mr. Duffield has been successful in getting members of the national association and is well pleased with results, having obtained about seventy-five members, which will entitle California to three delegates in the national convention, which takes place in Denver, July 17.

Q. R. Boynton, manager of Central Electric Plumbing and Heating Company, made a business trip to Stockton and Sacramento during early part of week.

W. S. Hanbridge has been in San Jose during the past week on electrical contractor's business.

JOBBERS PLAY GOLF.

While co-operation was the purpose of the gathering of a number of electrical men at Del Monte, California, last week, competition in the regular golf match proved to be the most interesting feature of the meeting. The jobbers vied for two cups, the Patton trophy and the Ever Read cup, E. J. Dwyer of Seattle proving the victor in the first match and A. H. Elliott winning the second. The manufacturers' representatives competed for a cup presented by the jobbers' association, Gregory carrying off the honors. The results of the play follow:

	Patton Cup.			Ever Ready Cup.		
Player.	**Score.**	**Hdc.**	**Net.**	**Score.**	**Hdc.**	**Net.**
Hillis	97	S.	97	97	5	92
Berry	87	+12	99	87	..	87
Dwyer	**109**	**27**	**82**	109	15	94
Carter	103	2	101	103	7	96
Gleason	99	+6	105	99	10	89
Hall	108	5	103	108	15	93
Elliott	106	18	88	**106**	**20**	**86**
Reynolds	105	..	105	105	5	100
Dederick	113	27	86	113	24	89
Goodwin	100	+13	113	100	+1	101
Berger	127	27	100	127	24	103

Manufacturers'-Jobbers' Cup.

	Score.	Hdc.	Net.
Sanderson	85	+8	93
Bibbins	97	10	87
Gregory	**96**	**18**	**78**
Young	129	24	105
Squires	139	20	119
Lauritzen	88	5	83
Herr	149	24	125
Poss	109	10	99
Oakes	118	20	98
Steel	110	24	86
Russell	160	24	134

LOS ANGELES NEWS LETTER.

The city of Los Angeles Aqueduct Department have received bids for the transformers and generators for power plant No. 1 in the San Francisquito Canyon and will receive bids for the wheels on November 24th.

The Pacific Electric Railway Company have authorized the issuance of $100,000,000 in bonds for extensions, betterments and improvements. One thousand miles of extensions are contemplated, reaching from Santa Barbara to San Diego. Grading is rapidly nearing completion on the Colton branch and surveying parties are now working in San Bernardino, Orange and Ventura counties. Right of way men are now working in the San Fernando Valley, with the intention of extending the lines from Burbank on to Santa Barbara.

The Economic Gas Company have filed suit in the Superior Court restraining the City Council from enforcing the 80 cent rate. Consumers connected to this company are now receiving gas as low as 73¾ cents per 1000 feet, under the discount system.

Fire Chief Ely, of Los Angeles, has made his report to the Board of Fire Commissioners on the fire alarm situation. The report of Chief Ely was the result of an extended trip throughout the East, gathering data on different systems. While the report does not recommend the adoption of the Cregiar apparatus, it endorses that system of construction as being superior to the series system. The board have the matter under consideration and are expected to make a report to the special committee appointed by the council, recommending the installation of a complete system covering the entire city, 60 per cent of the installation to be underground. The improvement is estimated at $500,000.00, which includes a new central station building.

C. H. Grist has submitted a proposition to the City Trustees, Beaumont, California, for an electric lighting plant, to be established in that city. If the City Trustees will guarantee fifty 80 c.p. street lights at a cost of $2.50 per month, he will establish the plant at once.

SPECIAL CORRESPONDENCE FROM THE PACIFIC NORTHWEST.

Floods in Western Washington, due to heavy rains and rapid melting of snow, washed out a bridge carrying Seattle's municipal water and power pipe lines, and also damaged the power dam above Moncton. As a consequence, the city streets were unlighted for several nights and a water famine was averted only by the most careful use of the reserve water supply in the service reservoirs. Repairs have been started on the pipe lines and it is believed that no further trouble will be experienced.

The delivery of sixteen more prepayment cars to the Portland Railway, Light and Power Company will complete the company's order of 100 cars for 1911 and will give a total of 601 cars in operation in Portland. The capacity of the barns has been increased to care for this rolling stock, which gives Portland more operating cars than any city of equal population in the country. This company has almost completed its second reinforced concrete substation at the terminus of the 28-mile steel-tower transmission line from the new power plant on the Clackamas River, near Estacada. This line has 228 double towers, temporarily equipped with a single three-phase line.

The executive committee of the Pacific Coast Claim Agents Association met at Portland during the past week to arrange for the annual convention at Los Angeles next May. The principal address was by B. S. Josselyn, president of the Portland Railway, Light and Power Company, who stated that it was his theory "that personal damage claims against the railways can only be handled by an absolute regard for the responsibilities involved. If you settle every case on the theory of the golden rule, 'to do to others as you would have them do to you,' you will create in the public mind an impression of fairness and justice; you will procure a settlement more often and less lawsuits. If a transportation company is responsible for the injury, then, I say, a full and complete settlement should be made." Those in attendance at the meeting were: T. G. Newman, of the Whatcom County Railway & Light Company, Bellingham, Wash.; George Carson, of the Seattle Railway Company, Seattle, Wash.; G. N. Smith, of the O.-W. R. & N. Co., Portland; A. M. Lee, of the Northern Pacific Railway Company, Seattle; T. G. Aston, of the Washington Water Power Railway Company, Spokane; E. M. Grover, of the Northern Pacific Railway Company, Tacoma, Wash.; E. H. Odell of the Tacoma Railway & Power Company, Tacoma; H. K. Reif, of the Spokane, Portland & Seattle Railway, Portland, and B. F. Boynton, of the Portland Railway, Light & Power Company, Portland.

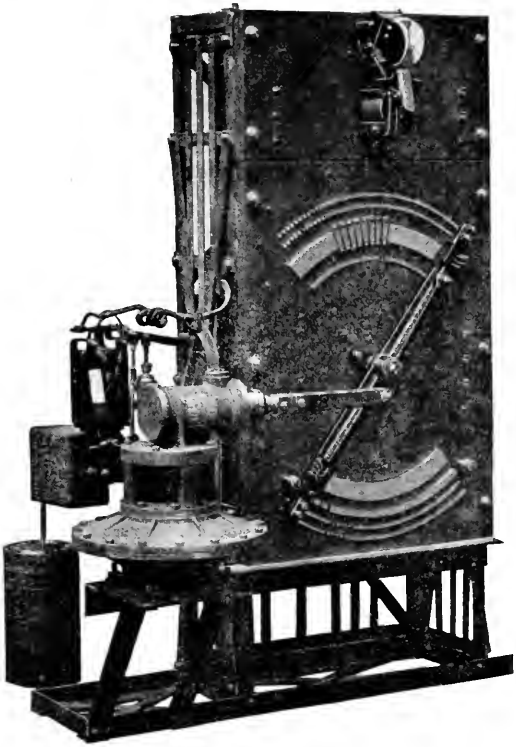
The United States Reclamation Service is investigating the feasibility of extending the Okanogan project in Washington by the addition of two units. Both will be irrigated by pumping. One unit includes 1100 acres in the present project limits, known as the Robinson flat, and requires a lift of 180 feet. The other will take in lands in the Colville Indian reservation. To perfect this it will be necessary to construct a power plant on Salmon River and transmit power to the various points from which water will be pumped into canals from the Okanogan River.

INDUSTRIAL

NEW REGULATOR FOR AUTOMATICALLY VARYING THE SPEED OF TWO MOTORS.

The Cutler-Hammer Manufacturing Company of Milwaukee has for some time built pressure controlled automatic speed regulators for varying the speed of single motors operating on mechanical boiler draft systems. The accompanying illustration shows a new type of controller which regulates two motors, stops or starts either or both of them and maintain the desired pressure in the boiler within certain fixed limits.

The panel illustrated was installed in connection with a 3½ h.p. motor and a 5 h.p. motor, each driving a triplex oil pump feeding oil-fired boilers. The oil is fed to the boilers under pressure of about 35 lbs. per square inch. The oil fed varies with the demands on the boilers. In this particular case the small pump takes care of ordinary operating conditions and both are used only when heavy load conditions prevail.



Cutler-Hammer Two-Motor Automatic Pressure Controlled Starter and Speed Regulator

The small motor is started automatically and accelerated to normal speed and above this if necessary. If this does not supply the oil needed the clapper switch, at the top, closes the circuit to the large motor and this is brought up to the speed required. When the demand on the boiler decreases so that the smaller motor can again do the work, the 5 h.p. motor is cut out of the circuit.

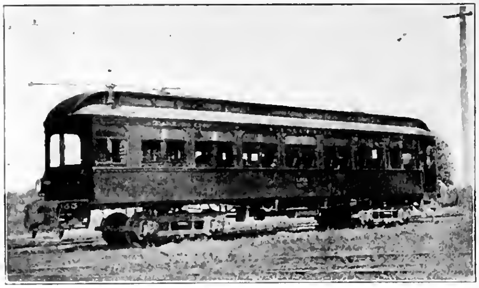
This controller, therefore, not only eliminates the need for an attendant and reduces power consumption to a minimum but it accomplishes the result precisely and infallibly; better than by manual operation.

NEW EQUIPMENTS OF TOLEDO, BOWLING GREEN & SOUTHERN TRACTION COMPANY.

The Toledo, Bowling Green & Southern Traction Company has purchased four quadruple equipments of Westinghouse No. 304 interpole railway motors and Westinghouse HL Control, arranged for operation from either end of the car. This company is replacing several old equipments with more modern apparatus designed to decrease maintenance costs and to give more efficient service.

While the change from the old to the new equipments is being made very gradually and only a few of the new ones, Fig. 1, are in operation, the performance of these indicates that with them maintenance costs will be considerably decreased.

The Westinghouse No. 304 motor, Fig. 2, is of the interpole type, with split frame and rated at 75 h.p., at 500 volts and 90 h.p., at 600 volts. By the use of interpole sparkless commutation is insured under all loads. This motor is lubricated with the oil and waste method with separate oil gauging reservoir. The oil is fed to the bearings by capillary attraction through a compartment filled with wool waste which effectively prevents any foreign matter from entering the



Car Equipped With New Type Motor Control.

bearings. The armature is of the Westinghouse spider construction and has a bolted commutator. The field coils are strap wound and spring packed which prevents chafing of the insulation due to vibration. This motor is peculiarly adapted for interurban or high speed service because of the relatively high armature speed.

The use of Westinghouse HL Control affords many advantages, chief of which are: a minimum of space is required by the master controller on the car platform; all heavy current carrying parts are located beneath the car, thereby reducing all possibility of injuries to passengers from controller "blowouts"; one or more cars can be operated in trains; the contacts are held together pneumatically, under heavy pressure, irrespective of line voltages.

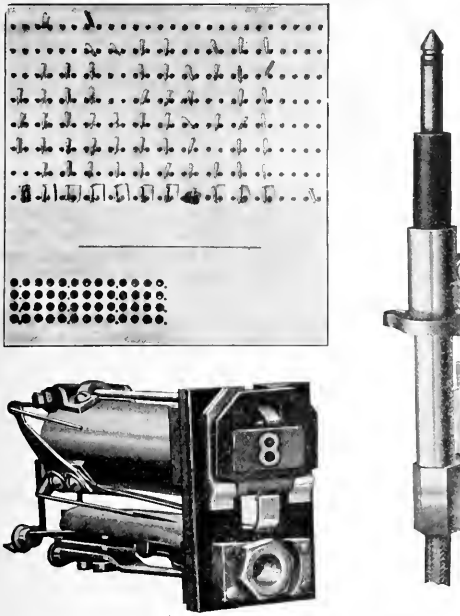
Figs. 3 and 4 show open and closed views of the master controller used with HL control.

MOUND HOUSE PLASTER CO.

The Mound House Plaster Co., owning extensive deposits of gypsum and gypsite at Mound House, Nevada, has equipped a sixty ton mill for calcining the material before shipping to their Wall Board plant at Emeryville, Cal. The company has leased the property of the Realty Syndicate at Hollis street, Emeryville, together with the buildings. The machinery for the hydraulic press equipment has been ordered from the Plate Glass Co. of Pittsburg, Pa. Fairbanks, Morse & Co. have the contract for the complete electrical equipment, including the installation of the 275 horsepower motors.

IMPROVED PLUG SWITCHES.

The Kellogg Switchboard & Supply Company have recently designed a new plug switch which differs very materially from the type previously used. When a plug is returned to its seat, it is necessary for the operator to force it in place in order to operate the plug switch springs. This method of operating makes it possible to use stiff springs, and hence, as platinum is used, the contact obtained is as reliable as that of a switchboard key.



Details of Improved Plug Switches.

This plug switch is mounted in a vertical position, thus making it practically impossible for dust to collect on the contacts. As it occupies a very little space, almost as many plug switches with associated plugs can be mounted upon a plug shelf as is possible when plugs with ordinary plug seats are used.

When a plug is forced into the plug switch, the sleeve of the plug makes contact with a metal roller, which in turn operates a small lever and closes or opens the plug switch contacts, depending upon the spring combination of the plug switch used.

New Enameled Head Gear.

The enameled head bands shown in the illustration are thoroughly insulated and are of light weight and inconspicuous when worn. They are proving especially serviceable in railway telephone dispatching work.

OCTOBER'S EARNINGS OFF 5 PER CENT FROM THE PRECEDING OCTOBER.

In sharp contrast with September, in which sales of the Western Electric Company showed an increase of 12 per cent over September, 1910, October shipments showed a decrease of 5 per cent compared with October a year ago. At the time, however, it was explained that the September gain came from orders booked earlier in the year, the company computing its business on the basis of shipments and not orders received, and that September's good showing did not mean an increase in orders received during that month.

But two more months of the companys year remain and it now seems fairly certain that the whole year's business will run very close to $66,000,000 which will make 1911 the second best year in the company's annals, being exceeded only by 1906, with sales of $69,000,000. An encouraging feature of the rapid strides the company made in the last three years is that the growth has been under normal conditions, and should, therefore, prove to be more or less permanent in character. The 1906 year was one of abnormal development in the telephone and allied industries, followed by a violent reaction.

Sales of the Western Electric Company for the ten months of the current year are about 3 per cent ahead of last year, the foreign branch of the company's interest showing up somewhat better than domestic business. In the United States during October all sections except the Pacific Coast district showed decreases. The East has been the section of the country to show the greatest falling behind.

TRADE NOTES.

S. O. Dolson, an electrical engineer for the Pelton Water Wheel Company, has gone to Butte County to install two Pelton water wheels of 800 h.p. each, at the Big Meadows damsite of the Great Western Power Company. These wheels will be direct connected to two General Electric generators and will be controlled by Pelton governors. The power generated will be used in connection with the big dam construction plant.

The Kellogg Switchboard & Supply Company has closed a contract with the Flathead Telephone & Telegraph Company for several exchanges in Montana that connect with the Lane Syndicate's lines, which are now operating through from Seattle to Butte. H. C. Goldrick, Pacific Coast manager for the Kellogg Switchboard & Supply Company of Chicago, reports that November, thus far, has been the best month of the year. Although there have been no very large orders there has been a good volume of small business.

Since the fire of 1906, Pierson, Roeding & Co., of San Francisco have been waiting for an opportunity to secure ground floor offices in a suitable location, and the completion of the Rialto Building has now made this possible. They have fitted up the southeast corner of the ground floor of the Rialto Building, and on December 2d, will remove from the Monadnock Building to their new location in the heart of the electrical jobbing district. A feature of the new arrangement will be a display room for exhibiting the firm's lines, including electric railway and transmission materials, storage batteries and high-tension oil switches. The new address will be No. 118 New Montgomery Street.

NOTICE OF MEETING.

An informal dinner meeting of the American Institute of Consulting Engineers will be held Friday, December 1st, at 7 p. m., at the Aldene Club, Fifth Avenue and 23d Street, New York City, for the purpose of welcoming the new members, and discussing matters of general interest to the Institute.

NEWS NOTES

FINANCIAL.

FALLS CITY, ORE. The water bonds have been awarded to the Bank of Falls City. The bond issue is for $5000, running 20 years at 6 per cent. The purpose is for the extension of pipe lines of the city's water system.

SIERRA MADRE, CAL.—The $111,000 bond issue for the purchase of the plant of the Sierra Madre Company and for further development and extension of the system recently voted upon, has been passed by a large majority.

EUGENE, ORE.—Mayor Berger has signed and delivered $13,000 worth of the city's lighting bonds. Stephen Smeed, owner of the Hotel Smeed Building and of a fine farm near Walterville, has taken up the first $5000 of the bonds, and W. T. Campbell, city fire chief and capitalist, has taken $5000.

LOS ANGELES, CAL.—The Pacific Electric Company has filed with the county clerk a copy of papers authorizing a bond issue of $35,000,000. Of this amount $9,000,000 is set aside to guarantee the underlying bonds of the company, and the remainder will be used for betterments and in construction of the Big Creek power project in San Joaquin Valley. The Big Creek power development will be used in the operation of railroads and in the development of electric power pumping in Southern California.

SAN FRANCISCO, CAL.—Articles of incorporation have been filed by the San Francisco, Napa & Calistoga Railway, the capital stock of the corporation being $2,000,000. Prominent San Francisco and Oakland residents are among the incorporators: Alfred Sutro, T. V. Maxwell, Charles C. Sullivan, Guy C. Earl and W. H. Spaulding. The new railroad company will take over the holdings of the San Francisco, Vallejo & Napa Valley Railroad Company, which institution obtained its holdings from the Vallejo, Benicia & Napa Valley Railroad Company.

FAIRFIELD, CAL.—A deed of trust of the Sacramento & Woodland Railroad Company, a branch of the Vallejo & Northern, to the Mercantile Trust Company, of San Francisco has been filed with the county recorder. The deed is to secure bonds for $1,000,000 to be issued for the purpose of completing the road between Sacramento and Woodland. The mortgage covers the land included in the right of way, the machinery and shops, the electric power plants, the depots and sites, the ferry and other boats, the telegraph and telephone lines and all leases that the company possesses.

STOCKTON, CAL.—Papers permitting the Tidewater & Southern Railway Company to create a bonded indebtedness of $900,000 were filed in the office of the county clerk yesterday by Attorney A. L. Levinsky, who has, from the inception of the company, represented the officers in all matters. The bonds are to draw 5 per cent. The Union Trust Company of San Francisco will handle the bonds. The documents were signed by Karl C. Brueck, president; J. A. Cooley, Byron A. Bearce, J. L. Craig, George F. Schuler and T. J. Wisecarver, directors. Work is going forward on the new interurban road, which is being built between Stockton and Turlock through Modesto.

PALO ALTO, CAL.—Contending that the business men and property owners of Palo Alto should not encourage a rate cutting campaign intended to destroy the $200,000 investment of this city in its municipal power plant, the Board of Public Works has directed the attention of the local Chamber of Commerce to the large amount of patronage that is being given the United Gas & Electric Company. At a meeting held last week facts and figures were presented to the Chamber of Commerce showing the activity of the private corporation in the business district of the city. The names of those who have been using outside power and light were read at the meeting and an appeal will be made to the business men to support the municipal plant.

INCORPORATIONS.

LEWISTON, IDAHO.—In the County Auditor's office have been filed articles of incorporation for the Valley Development Company authorized to engage in water power and electrical development enterprises. The capital stock is $100,000, the shares being of the par value of $100 each. The incorporators are F. H. Nourse, E. Kilham and E. H. Booth, all of Lewiston.

RENO, NEV.—Articles of incorporation of the Nevada Valley Power Company have been filed in Reno and Carson. The company is incorporated for $2,500,000. A. D. Ayers, H. B. Danforth and A. A. Smith of Reno, and Milton S. Hamilton and F. J. Early of Oakland are the incorporators. They plan to build a plant on the Truckee River east of Reno, and to compete with the Hammon interests. The plant is to develop 4000 h.p.

TWIN FALLS, IDAHO.—Articles of incorporation have been filed with the county auditor by the Twin Falls, Artesian City and Oakley Interurban Railway Company. The capital is placed at $500,000 of which $180,000 is subscribed. Twin Falls is designated as the place of business. Harry T. West is president of the company. The purposes and powers are to construct, maintain and operate interurban railways in Twin Falls and adjacent counties; to construct and operate warehouses, flour mills, to locate and develop power rights, dam and reservoirs and canals for irrigation purposes, operate power houses, etc.

BAKERSFIELD, CAL.—Backed by capitalists of national prominence and having for its purpose the erection in Kern County of plants and lines for the supplying of light and power to towns, prospective railroads and mines, the Southern Sierra Power Company has given notice of its intention to invade the Southern San Joaquin Valley counties by filing articles of incorporation. The company is capitalized for $5,000,000, divided into 50,000 shares, and is at present operating in Colorado and Wyoming. Delos A. Chappell, Lawrence C. Phipps and C. F. Potter are the incorporators, and with T. S. Hayden and G. Wood compose the directorate. Lawrence Phipps Jr., the steel magnate of Pittsburg, will come to Kern County soon to look over the situation.

ILLUMINATION.

SUNNYSIDE, WASH.—This city will shortly install 7½ ampere magnetic lamps.

COLFAX, WASH.—The City Council has decided to install a number of street lights.

CORVALLIS, ORE.—The City Council has decided to grant to Col. W. H. McGoldrick a proper franchise for the operation of a gas plant.

ABERDEEN, WASH.—This city will install new arcs and tungsten lights on local streets. The power is furnished by the Grays Harbor Railway & Light Comany.

VICTORIA, B. C.—This place will consider cluster lighting system extensions at the next municipal meeting. Petitions will be presented urging the lights installed on a number of local streets.

TONO, WASH.—The Washington Union Coal Company, a subsidiary of the O.-W. R. & N. Co., has made an appropriation of $500,000 of which $250,000 will be expended for a light and power plant and 60 new houses in this city and vicinity. Other improvements will be made to mines and other property.

PASCO, WASH.—Evans, Dick & Co., were awarded the contract for furnishing and installation of 84 street light posts, with three cluster lights equipped for use. The firm's bid for the style of posts selected by the council was $5980.

MARTINEZ, CAL.—An application has been filed by Van F. Britton for a franchise for operating and maintaining gas mains and other pipes along the county roads, between the towns of Antioch and Pittsburg.

SANTA ROSA, CAL.—The bid of $200 made by the Pacific Gas & Electric Company, for permission to lay gas pipes and extend its mains along the Sebastopol and other roads, was accepted and the franchise granted.

ALBANY, ORE.—Col. W. H. McGoldrick, to whom the City Council recently granted a gas franchise in the city of Albany, has just been granted by the county a similar franchise which will be in conjunction with the city franchise.

CHICO, CAL.—A fifty year-franchise has been granted by the Board of Supervisors to the Pacific Gas & Electric Company to lay down and maintain gas pipes and mains for conducting gas to Chapmantown, Chapman's North Addition, Oakdale, Davis tract, etc.

LEWISTON, IDAHO.—Local Manager Henry M. Jones of the Pacific Power & Light Company, announced that plans are being completed for extending the gas mains to the University addition residence section, as far south as Sixteenth avenue. The improvements are to be completed not later than January 1st.

DUVAL, WASH.—Roy W. Comegys, of this city, who, with associates recently secured a franchise from King County for an electric light and water system franchise in this city and vicinity, will start work on the project at once. The franchise provides for the erection of pumping station, pipe lines, transmission lines, dam, etc., at a cost of between $200,000 and $300,000.

TRANSMISSION.

SAN JOSE, CAL.—The Supervisors have accepted the bid of the Great Western Power Company of $110 for the power pole line franchise that the corporation recently asked for and the franchise was awarded.

BUHL, IDAHO.—O. G. Gray has been here recently representing Salt Lake and Denver capitalists as a consulting engineer and has made investigations of the Thousand Springs power site. It is probable that work will be started shortly on the plant.

TUCSON, ARIZ.—The Great Western Power Company will commence active operations in construction of a $1,000,000 reservoir and power project in Sabino Canyon. This will irrigate 6000 acres. A road will be built to the canyon for transporting materials from Tucson.

VISALIA, CAL.—The Board of Supervisors has granted a franchise to the Pacific Light and Power Company, a branch of the San Joaquin Light and Power Company, of Fresno, to extend their poles and lines over Tulare County. The company paid into the treasury $100 for the franchise.

FRESNO, CAL.—The Board of Supervisors has adopted an ordinance granting to the Pacific Light & Power Corporation a franchise to construct and for the period of 30 years to operate and maintain an electric tower or pole and wire system upon certain public highways in the county of Fresno.

PORTOLA, CAL.—Work will at once be started on the construction of a dam on Grizzly Creek to furnish power for the generation of electricity, to be used in furnishing lights to the town of Portola. The Reno Mill and Lumber Company recently secured the water rights and franchises of the Portola Light & Power Company, and this work follows close on the outcome of that deal. Twenty men were taken to the site last week and the work will be pushed rapidly to completion. The estimated cost is $40,000.

PASCO, WASH.—Chief Engineer McGee of the Pacific Power & Light Company's engineering staff, made a preliminary survey of the site of the company's projected transmitting station. As soon as Mr. McGee can prepare profile maps, etc., contracts will be let for the project. The first building will be a distributing warehouse, 100x200 feet, with 60 feet walls. Other buildings will be established as soon as possible.

EUREKA, CAL.—As the result of negotiations which began several weeks ago, the Blue Lake lighting system, owned by the Minor Mill & Lumber Company, has been formally purchased and taken over by the Western States Gas & Electric Company. The generators which have thus far supplied Blue Lake with electrical energy were not bought by the Western States Company, only the distributing system being taken ont. A crew of linemen will be put to work at once extending the transmission system of the Western States Company from Arcata to Blue Lake and within a few days the same current which is now lighting Eureka, Ferndale, Fortuna and Arcata will also be lighting Blue Lake as well as Glendale, a few miles north of Blne Lake. With the purchase of the Blue Lake system the Western States Gas & Electric Company now has control of the entire lighting and power sitnation in Humboldt County. It is stated that with the centralization of the former independent systems under one management a much more economical production of electrical energy will result with a consequent benefit to the consumer.

TRANSPORTATION.

WILLOWS, CAL.—President Donohue of the Sacramento Valley West Side Electric Railway, will make application to the County Supervisors for a franchise through Glenn County for the new electric road.

EDMONDS, WASH.—John Appleton and George Walsh of Seattle met with the local Chamber of Commerce to enter into negotiations for the construction of a street car line to connect this city with the interurban.

MEDFORD, ORE.—An interurban railroad connecting Medford, Ashland, Grants Pass and Jacksonville now seems to be a certainty, as the organizers have applied for a franchise, which will come before the next meeting of the City Council.

CALDWELL, IDAHO.—O. G. F. Markhus, manager of the Idaho-Oregon Power Company, met with the local municipal council November 6th and petitioned that body for an electric railroad franchise covering a number of local streets. No action on the matter has been taken.

BOISE, IDAHO.—A. B. Smith, representing unknown interests, asserts that his company will construct an electric railway line through Sonth Boise to Nampa, and possibly connect the territory tributary. Another company is also petitioning the county for a franchise.

ALBANY, ORE.—According to reports, all obstables have been cleared for the constrnction of the Oregon Electric railway line between this city and the present terminus at Salem. Deals have been closed for several isolated strips of right-of-way. It is further said that regular trains will be in operation by January 1st, 1912. Practically 50 per cent of the grade has been completed and orders have been placed for steel and track laying facilities.

IRONDALE, WASH.—Reports from this place state that the sale of stock is progressing to such a degree as to warrant the immediate preliminary survey for right-of-way of the proposed interurban line for the Olympic Railway Company. Thomas Atwell, manager, stated that the project will probably be financed by Peabody, Houghteling & Co. Work will soon start on surveys and other preliminary work, with the intention of completing all preliminary work before February, 1912.

ALPHABETICAL INDEX TO ADVERTISERS

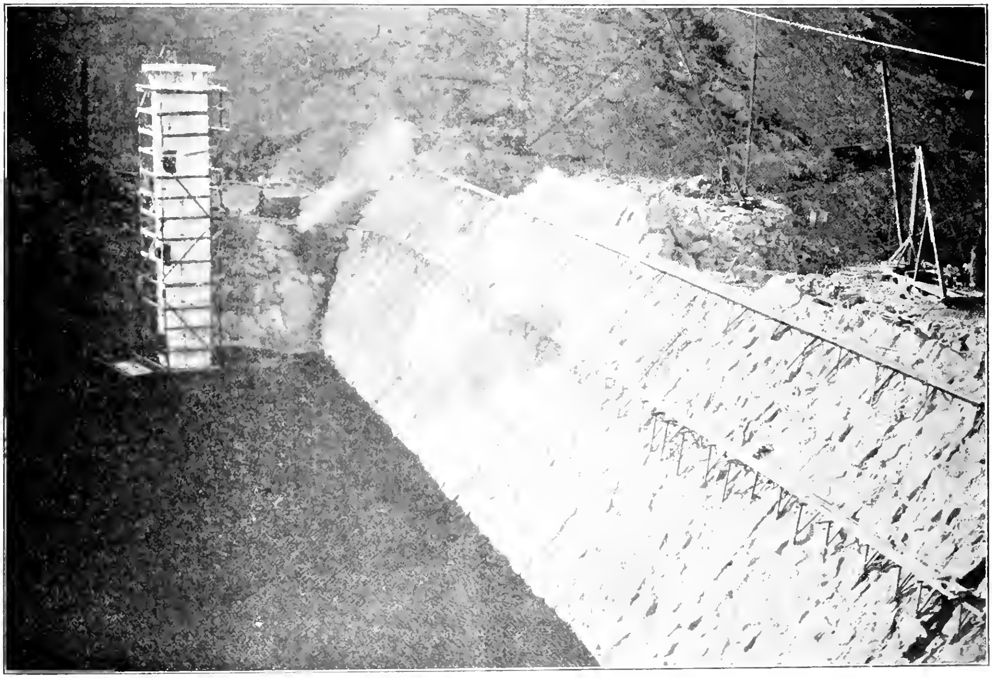
JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

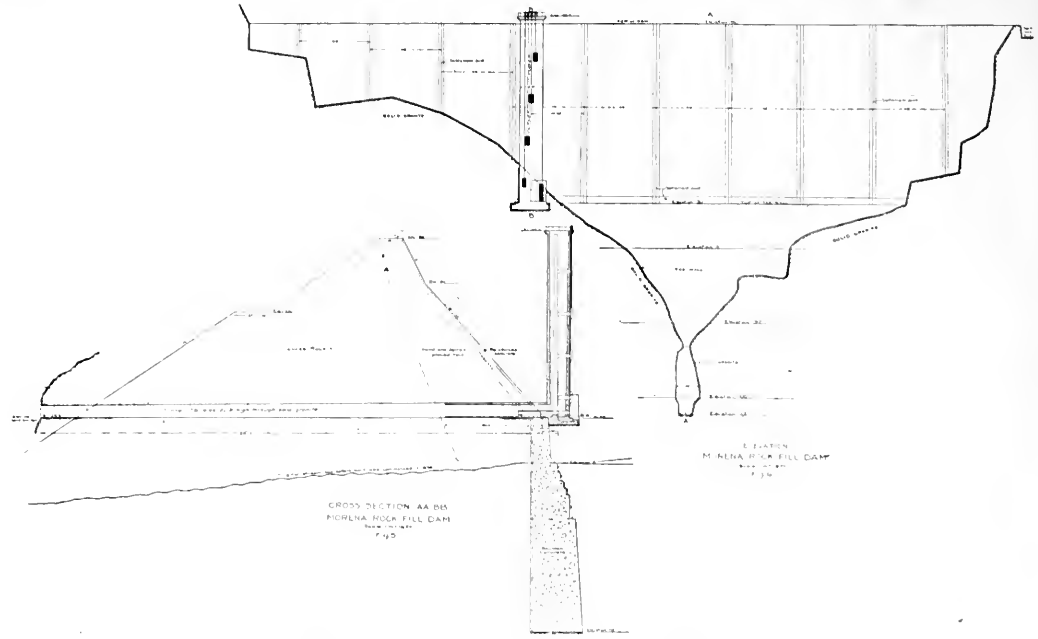
VOLUME XXVII — SAN FRANCISCO, DECEMBER 2, 1911 — NUMBER 23

HIGHEST ROCK-FILL DAM IN THE WORLD

The Pacific slope is to be credited with originating many achievements in the engineering field which have created a precedent for the effete East and other countries to copy. Such feats as the construction of the heavy wrought iron pressure pipe of the Comstock in the early seventies in Nevada; the development of the Halliday cable street railway system in San Francisco; the creation of the thin arch dam of Brown in Bear Valley, San Bernardino County. The many pioneer rock-fill dams with wooden facing constructed in the old mining days in the California mountains, are now being surpassed by the modification of the same in the completion of the immense Morena rock-fill dam of San Diego which substitutes a veneered skin of reinforced concrete and masonry for the old wooden facing, and completes successfully the largest dam of this type in the world, 267 feet high from the foundation to the top, in a most satisfactory manner.

This work has been accomplished in connection with the completion of the works of the Southern California Mountain Water Company supplying the city of San Diego with water, owned by the brothers, John D. and Adolph Spreckels, residents of San Francisco. The city of San Diego has developed an extraordinary growth of population in the last twelve years, increasing from 17,000 people in the census of 1890 to 55,000 people at the present time. The supply of water to meet this growing population demanded


The Highest Rock-Fill Dam in the World Showing Outlet Tower



Morena Rock-fill Dam in Cross-section and Elevation.

prompt and heroic measures and the owners of this property, broad enough to realize the situation, undertook to build a number of storage dams to develop a reserve supply and anticipate the demand for water in the growing community.

This was rendered necessary owing to the fact that in this extreme southern end of the State of California, a number of dry years often appear in succession when the run-off from the mountain streams is very light, consequently large volumes of water must be impounded in the years of plenty to take care of the consumption and evaporation during the intervening lean years of light rainfall.

This company has now completed the following dams for impounding rainfall from the mountain watersheds:

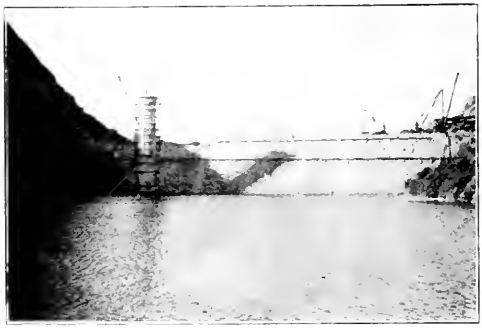
RESERVOIR SUPPLIES OF THE SOUTHERN CALIFORNIA MOUNTAIN WATER COMPANY.

Name of Reservoir.	Type of Dam.	Height Feet.	Outlet Altitude.	Area Acres Submerged.	Capacity in gallons.
Lower Otay	Rock-fill	150'	400'	869'	13,000,000,000
Upper Otay	Arched concrete	77'	521'	164'	1,090,000,000
ChollasHgts.	Earth and Steel Plate	34'	385'	17'	90,000,000
Morena	Rock-fill	265'	2912'	1370'	15,000,000,000
Total capacity					29,180,000,000

It will be seen that the little city of San Diego has now a reservoir capacity for its population of 55,000 almost equal to that of the Spring Valley Water Works system of San Francisco with over 400,000 population, and above four times that of the Peoples Water Company of Oakland, supplying Alameda and Berkeley with a combined population of about 300,000 people. There are many other sheds in San Diego within range of 30 miles of the coast, capable of being developed so that it can safely be said that water for a population of two and a half million can be conserved by intelligently making proper outlays, as numerous dam sites are available. The summit of the mountain range is about fifty miles from the coast at an altitude of from 4000 to 6000 feet, and the annual rainfall in this locality varies from 20 inches to 40 inches, depending on the contour of the mountains and the direction of the prevailing rainstorms which invariably float in from a southwesterly direction from the Pacific Ocean.

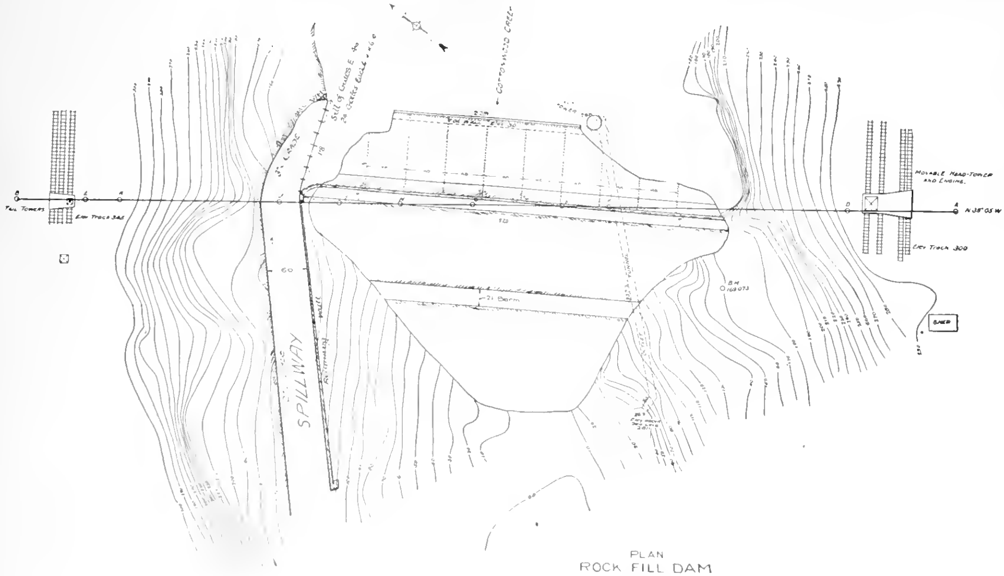
Morena Rock-Fill Dam.

This is located on the Cottonwood stream, which flows into the ocean near Tia Juana on the Mexican frontier. It is thirty-five miles in an air line south-



Morena Dam, Looking West.

east from San Diego and about seven miles north of the Mexican boundary line, past which the San Diego & Arizona Railway is now being built through the old town of Campo, which was a stage station of the

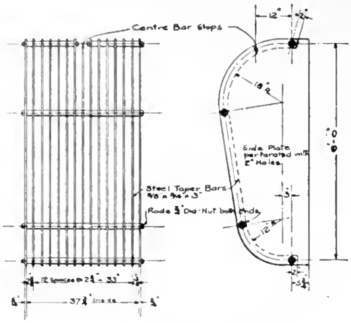


Plan of Rock-fill Dam.

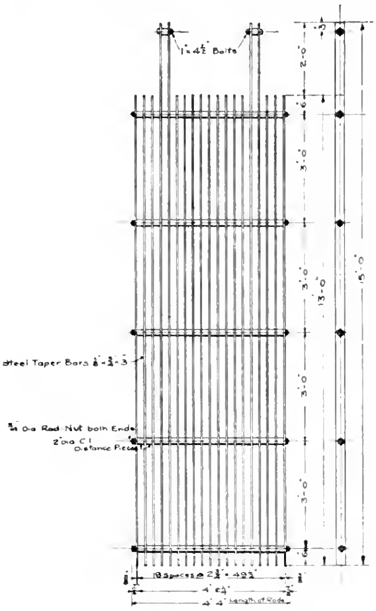
old overland wagon road in the early days before trans-continental railways were built. The dam is a rock-fill structure facing a narrow canyon gouged out of the solid granite cliffs that tower 500 feet high on each side of the gorge. This canyon is filled with enormous boulders throughout and in excavating the foundations at the site of the dam, a narrow fissure eroded by the ancient stream was found to be 112 feet below the stream bed at that point. A wall of rubble concrete 36 feet at the bottom and 12 feet thick 30 feet above the stream bed was the first construction done in 1896 when the project of building this dam was launched. Work was suspended with the toe wall up to the 30 foot contour in April, 1898, when about 120,000 cubic yards of rock-fill had been placed out of a total of 306,000 cubic yards required to complete the dam to the prescribed cross section. Work was resumed again after an elapse of eleven years by chief and consulting engineer M. M. O'Shaughnessy, Mem. Am. Soc. C. E., who, after a careful study of the situation, decided to change the upper slope from the top of the completed toe wall up to the 120 foot contour to 9 horizontal to 10 vertical and from the 120 foot contour to the top of the dam at the 150 foot level ½ horizontal to 1 vertical. In the new work of filling, it was decided to alter the character of the same by placing large six and ten ton blocks of granite on the up-stream face of the dam and have them well bedded and set in cement mortar of one cement to 2½ sand, and behind this masonry skin for a width of 50 feet to hand and derrick place all the stone and spall the same with small rock so that no cavities would exist in the structure. The top of the dam is 16 feet wide and crowned with a three-foot concrete coping for wave wash, and the back slope is 1½ horizontal to 1 vertical with a berm of 21 feet at the 100 foot contour to provide for future extensions in raising the dam. To obviate any serious cracking of the skin from settlement of the mass, vertical joints were arranged on 48-foot centers, as shown in the drawings. Through the rubble masonry at the present time the leakage is only 33,000 gallons in 24 hours under a head of 65 feet. It is proposed at some time in the future, if necessary, to put a thin slab of reinforced concrete on the top of the masonry which will break at the joints before mentioned. These joints to be subsequently calked with oakum and asphalt.

Upper Otay Dam.

As the freights from San Diego to Morena—a distance by wagon road of about sixty miles, with grades of 16 per cent and sometimes 18 per cent to overcome—cost up to about one cent per pound, it was imperative to diminish the quantity of expensive hauling to a minimum; hence the type of construction here described has been developed.



Detail of Grating for Outlet Valve
Four wanted complete



Detail of Grating for Mud Gate
One wanted complete

Possibly one of the most successful mass shots ever made with blasting powder was accomplished on this work August 30th, 1909, when 16¼ tons of powder in a chamber at the end of a tunnel drift 115 feet long broke 180,000 tons of granite rock at a cost of 4¼ cents per ton. This rock was afterward handled and placed in the dam by means of two Lidgerwood cableways, one 2½ in. in diameter, 1350 feet long and the other 2½ in. in diameter, 1100 feet long, which were able to pick up rock from 10 to 12 tons and convey them into the dam at a speed of about 300 ft. per minute. Five stiff legged derricks and two guyed derricks were used for placing rock in the skips and cables at the quarries and distributing them over the dam. Great care was used in keeping the derricks properly guyed to avoid breakage, as hauling supplies for renewals over the 60 mile road was somewhat expensive.

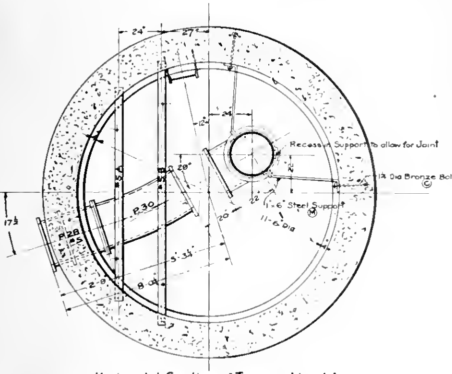
The control of the cables, which were about 200 feet in elevation above the dam were regulated by an ingenious though simple, electric system of signalling. The bells used in the old days were abandoned and an annunciator consisting of boxes having ten compartments each 8 x 8 in. deep were placed in view of the operator. The front of each compartment was closed by a pane of frosted glass and on each the following signals were painted, "Hoist," "Lower," "Go Out," "Come In," "Fast," "Slow," "Stop," with three spares for special signals. On the back of each compartment were mounted two Edison keyless wall sockets with 16-candle power, 110 volt lamps. The lamps were wired with a common return wire and an individual wire for the other terminal of each lamp, making 11 wires in all. These wires were No. 14 copper covered and cabled and

Lower Otay Dam.

the outside was protected by jute braid. Each flexible cable was 650 feet long and could readily be moved to any favorable position on the south or operating end of the dam. At the signalling end of the cable ten switches were mounted and normally held open by means of a spring requiring the pressure of the operator's fingers to close it. Switches were mounted upon an insulated base in such a way that the leads were brought into them without coming into contact with the wooden frame work. A 1¼ kw. 125 volt direct current compound wound generator was used to operate at a speed of 1650 r.p.m., which was driven by one C. H. Dutton 5 h.p. vertical type steam engine which was installed to operate at a speed of 300 r.p.m. This engine was supplied with steam tapped from one of the boilers of the big Lidgerwood engines. By this means a single man with the switch signal board was moved around the dam to the most effective points for observing the control and placing of rock as the work progressed, without interfering with guy wires and absolutely preventing accidents, as not a man was injured in 2½ years' operations from any confused signals.

The outlet arrangement consists of a reinforced circular concrete tower placed on bedrock in the reservoir basin and connecting with a tunnel 387 feet long, 8 feet wide by 7½ feet high, through which the water from the reservoir is drawn off. The outlet tower is 15 ft. 6 in. in external diameter, the concrete walls of which vary in thickness from 3 feet at the base to 20 in. at the top. The top of this tower is at an elevation of 155½ feet, on which an operating

deck of reinforced concrete is built for regulating the outer gates. These are of the Coffin Valve Company sluice type with vertical stems controlled by guides let into the concrete. Around each gate is a screen to keep trash and drift from entering the 24 in. circular cast iron pipes passing through the walls of



Horizontal Section of Tower on Line AA. Gate #5. Scale 3/8"=1 Foot.

the tower and connecting with a 30 in. vertical down pipe which discharges into the tunnel before mentioned. These outlets are located 28 feet apart vertically, so that the water may be drawn off under a light head from any of these levels. Between each opening and the down pipe there is a curved removable bolted flanged casting to enable the gates to be easily removed, if it is ever found necessary, and which is attached to Crane gates operated from platforms inside of the tower at the different levels, and which are used for emergency purposes only. The admission of water through the outer sluice valves relieves the leaf valves from any chattering effect developed by the spouting water which discharges into the down pipes flowing freely through the tunnel. There is also an independent 24 in. cast iron pipe which will be used for washing out the sediment which may in the future accumulate near the base of the outlet tower and which passes through its foundation and connects with the tunnel before mentioned. The inner 75 feet of this tunnel in solid granite—has been lined with concrete and connects with the base of the tower and encloses the pipes which discharge onto the floor of the tunnel, so that every precaution has been taken to have as simple and safe an outlet at a moderate expense as it was possible to obtain. From the outer end of this tunnel the water will be permitted to flow at present along the natural grade of the Cottonwood Creek until it is picked up above the Barrett dam site by the Dulzura Conduit which leads the water to the Otay reservoir.

This design of tower was decided upon after a prolonged study of many different types of outlet, and the fact that a similar one is now being built in Alabama is another tribute to the achievements of our western engineers in ignoring precedent and threshing out problems to logical conclusions.

In order to obtain a comparison with other similar engineering structures, a brief description of the Roosevelt Dam, Arizona, is here given:

It is of solid masonry and at its base occupies one acre of the bed of Salt River. It is 280 feet high, 170 feet thick at river bed and 16 feet thick at top and 1080 feet long at crest, it took 4 years to build, has 340,000 cubic yards of masonry in its contents and cost the Reclamation Service of the U. S. Government $3,468,000. The Morena is 267 feet high from the bottom of the foundations—which were excavated 115 feet below the old stream bed—to the top. It is 300 feet thick at the base and 550 feet along the crest, it has taken 5 years to build, has 306,000 cubic yards of masonry in its contents, covers 2½ acres on its foundations, and has cost Mr. Spreckels' water company $1,500,000 to complete.

It backs the water up for four miles through Morena Valley, forming a picturesque mountain lake, the shores of which are studded with glistening granite and bordered with live oak trees—and as it is solidly united to the primeval bedrock with all the skill and care that good workmanship could accomplish, it is safe to assume that it will last until eternity.

CANAL WORK IN OCTOBER.

The grand total of Canal excavation to November 1 was 153,055,640 cubic yards, leaving to be excavated 42,267,739 cubic yards, or less than one-fourth of the entire amount for the completed Canal.

The total for October was 2,331,678 cubic yards, as compared with 2,884,382 cubic yards in October, 1910, and 2,827,798 cubic yards in October, 1909.

The dry excavation amounted to 1,516,759 cubic yards, and was principally by steam shovels. The dredges removed 810,215 cubic yards, and 4,704 cubic yards were sluiced in the Central Division, in addition to the amount pumped into Gatun Dam by suction dredges. The progress on the locks at Gatun, Pedro Miguel, and Miraflores is referred to elsewhere in this issue.

In the Atlantic Division, the total excavation was 536,431 cubic yards. Of this total, 66,031 cubic yards were dry excavation, and the remainder was removed by the dredges in the Atlantic entrance.

The total excavation in the Central Division was 1,319,187 cubic yards, all of which was from the prism. The amount taken from Culebra Cut was 1,306,971 cubic yards, as compared with 1,320,314 cubic yards in October, 1910, the high record for that month.

In the Pacific Division, the total excavation was 476,060 cubic yards, 339,815 cubic yards of which were taken out by dredging at the Pacific entrance.

BURNING OF AN ELECTRICALLY OPERATED GOLD DREDGE.

Yuba Consolidated gold dredge No. 10 was burned last week, at the dredging grounds on the Yuba River above Marysville. It was recently completed at a cost of $200,000 and was insured for quite an amount. As no one was on board the dredge when the fire started, the cause of the disaster is not definitely known. The company made an excellent showing during the past year and the construction of another dredge is only a question of time.

MUNICIPAL ELECTRIC LIGHTING SYSTEMS[1]

BY C. L. CORY

At the last meeting of the San Francisco Section of the American Institute of Electrical Engineers, at which Honorable Max Thelen, attorney for the California Railroad Commission, made an address in connection with the recently adopted amendments to the Constitution of the State enlarging the powers of the railway commission and extending their control over other public service corporations than steam and electric railways, it was brought out that in the State of Wisconsin its railroad commission has practically the same control over the construction, operation and rates for service of the municipally owned public utilities as over the privately owned corporations providing service to the public.

Since the most valuable work has been done by it, and especially, since the decisions of the Wisconsin Railroad Commission have been almost universally adopted, at least in principle, it is certainly desirable to most carefully consider the important opinions and findings of this commission in the principal cases it has considered and especially the decisions it has rendered.

Such conclusions are of necessity in the form of generalities rather than specific instances, and, while it should be fully understood that the conditions in Wisconsin may and probably are very different from those existing in California, the application of these conclusions to two typical electric lighting systems in two different Pacific Coast cities give results which are certainly illuminating.

In arriving at a basis for a just fixing of rates, this commission has consistently maintained that the rates for current should be based upon the cost of the service.[2] Each consumer occasions expenses to the plant. In order that every consumer shall pay his just share of the expenses, it is necessary to apportion the expenses of the plant between the capacity and output costs, and determine what part of each class of expense should be charged against each particular consumer. Thus, a particular consumer installs in his residence thirty incandescent lamps, thereby necessitating the power plant to be ever ready to supply the necessary current should the consumer turn on all his lights. The particular consumer, however, except in rare instances burns only four lamps for a few hours each day. The consumer has thus forced the power plant to install sufficient capacity to care for maximum load conditions and should be charged a proper amount for this constant or capacity expense and also should pay a proper charge for the actual service rendered. Some eastern meters are installed so as to register these separate factors. It is then seen that operating expenses are of two classes—constant and variable.

Constant expenses are not affected by the business done but depend more on the capacity of the plant rather than any other factor. The variable expenses depend upon the amount of service rendered. The fixed or constant expenses should as nearly as is possible be charged proportionally for maximum capacity of each consumer while variable charges should be proportionally to the amount of service rendered.

The Wisconsin Railroad Commission in numberless decisions maintains that in the accounts of a public service corporation provision must always be made for depreciation. Depreciation is defined as that loss or shrinkage of value which inevitably occurs from time to time in the equipment of the plant, as a result of the employment of this equipment in the production of electricity. The loss may be due to wear and tear, to age, to the march of modern invention, or to the inadequacy or to any or all of these causes combined. The aim of a depreciation fund is in a word to keep the investment intact. Repairs and maintenance do not offset depreciation. Depreciation must always be taken care of in the operating costs which are charged directly to the consumer and not charged against construction, thus warping this account out of proportion and apparently showing large earnings.

The commission goes further and states that as depreciation is continually going on a just and proper method of providing for it is to include depreciation under the head of operating expenses, charging off to the constant expense account such proportion of the depreciation as rightfully belongs under this heading and to the variable expense account such proportion as properly belongs under its heading.

In the course of its investigations the commission found it necessary in cases of improperly arranged accounts or in case of no accounts being kept at all to order properly classified and detailed reports of expenses for the future.

Furthermore in the matter of municipal plants the commission found certain cases in which the accounts showed that taxes were not assessed against these plants and consequently the commission put itself on record as opposed to such practice. The commission stated that as capital invested in a public plant is the capital of the municipality or the taxpayers, the taxes and interest are a necessary factor in the determination of the cost of furnishing the service.

In order to apply the methods of approximately obtaining the cost of service to each customer, as is so clearly and completely set forth in the above quotations, I have worked out on two typical electric lighting systems on the Pacific Coast the segregated costs, setting forth separately the fixed and variable expense as affected by the load factor as well as the quantity of electrical energy used by each customer. System No. I has its power generated with steam, while System No. II receives its power at a substation outside of the city limits, stepping down from 60,000 volts to the voltage of distribution allowed within the city power.

Probably no point is of such serious consequence in connection with the operation of a municipally owned lighting system as the low load factor resulting from the fact that most of the electrical energy used is for residence lighting, the period of use being of probably not more than an average of two hours each night out of the twenty-four hour day. Again, the wide difference between the maximum demand or peak load and the average load for the year is caused by the difference in the seasons between December

[1] Paper read before the Fourteenth Annual Convention League of California Municipalities.

[2] Wisconsin Railroad Commission Reports, Vol. 3, pages 299-221; Vol. 4, pages 219-229; Vol. 5, pages 560-574; Vol. 5, pages 742-791.

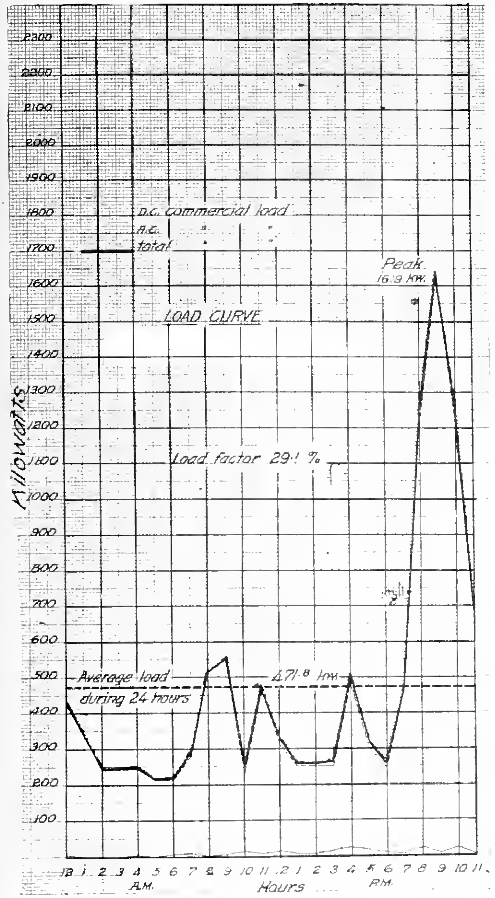


Fig. 1. Peak Load Conditions for Summer Months.

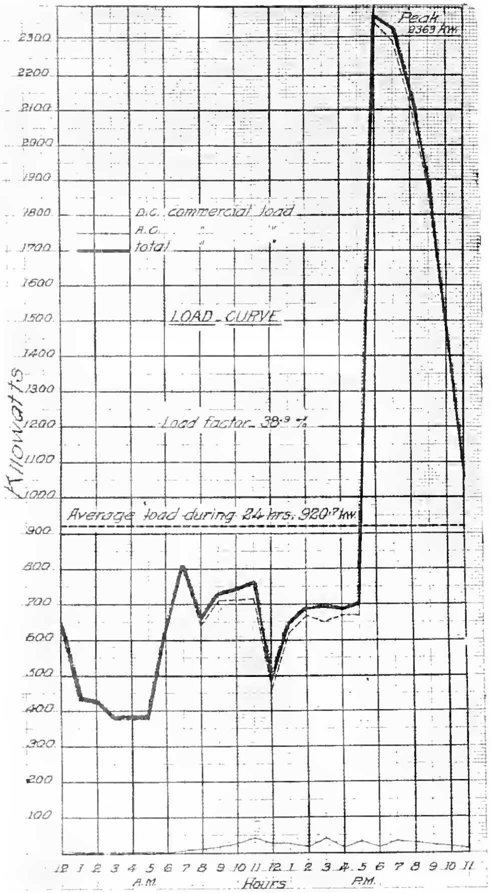


Fig. 2. Peak Load Conditions for Winter Months.

and June, and it is not extraordinary to find that the peak load for residence and retail business lighting during the last few days of December is 50 per cent greater than the corresponding peak load during the summer season. As an illustration of this Fig. 1 is the load curve of System No. II on June 30, 1910, showing a maximum load of 1619 kw. at 9:00 p. m., lasting for a very short time. In fact, the load above 1200 kw. was only of two hours' duration, or between 8:00 and 10:00 p. m. The average load for the twenty-four hours was 471.8 kw., making a load factor of 29.1 per cent for the day.

Fig. 2, on the other hand, is the load curve of System No. II six months later, or on December 31, 1910. The actual peak on this day was 2363 kw., or almost exactly 50 per cent greater than on June 30. This peak of practically 2400 kilowatts, occurred at 6 p. m. and lasted for the better part of an hour. The load above 1200 kw. continued for a period of 5½ hours, or between 5:15 and 10:45 p. m. The average load during the twenty-four hours was 920.7 kilowatt, or nearly 100 per cent greater than on June 30, six months previous. The load factor for the day was 38.9 per cent. While these curves are for particular days, yet they are typical of the summer and winter load, neither of them being abnormal for the two seasons. An annual load factor for such electric lighting service of from twenty to thirty per cent is not uncommon, while, in comparison, due to the large use of electrical energy for power in the operation of manufacturing plants, transportation systems, mines, etc., the load factor of extensive transmission systems, which often include a number of hydroelectric as well as steam driven central stations, have a load factor of between seventy and seventy-five per cent.

Another point of importance in connection with the construction and operation of municipally owned lighting systems is the rapid growth required of such systems in many progressive western cities. The increased investment demanded each year must be met ordinarily by a new bond issue and to show what this would mean in the city where System No. II is installed, I have given below the year, the additions to plant, and the total investment for a period of seven years. During this time the additions to the plant varied from a minimum of $35,000 to a maximum of

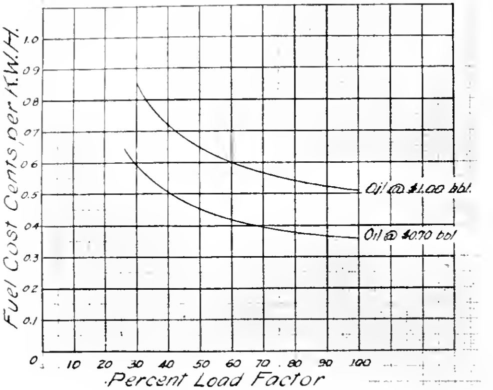


Fig. 3. Dependence of Fuel Consumption Upon Load Factor.

$120,000 per year, the total investment increasing in the seven years from $155,000 to $565,000, or practically three and a half times its original figure.

To meet this growth very many times requires additional money which ordinarily cannot be raised except by new bond issues.

Under favorable conditions, if there be a surplus, it may be used for short periods to do needed construction work and later, the cost of such construction work may be met by a bond issue, reimbursing the surplus fund of the electric lighting system from such bond issue. In such cases it may sometimes be proper to expend, for new construction, money which properly must be set aside each year to cover depreciation, provided such accounts are always properly carried on the books of the system so that the depreciation reserve, temporarily used for new construction, is replaced and used as required at such time as a new bond issue renders again available the funds actually and in reality required for extensions of the system and new construction.

INCREASED INVESTMENT IN SYSTEM
SYSTEM NO. 11

Year.	Additions to Plant.	Total Investment
First		$155,000
Second	35,000	190,000
Third	40,000	230,000
Fourth	95,000	325,000
Fifth	75,000	400,000
Sixth	120,000	520,000
Seventh	45,000	565,000

In determining the fuel cost on the steam plant switchboard per kilowatt-hour at different load factors I have used the figures given by C. R. Weymouth, M. E., in a paper entitled "A Method for Calculating Steam Power Plant Economy," for condensing direct connected steam driven units based on plants installed at Pacific Coast railway terminal points.

The kilowatt-hours per barrel of oil as there given for a 1500 kilowatt condensing plant operating 24 hours per day are as follows:

Load Factor.	Kw.-hr. per bbl. of oil.
12 hr. Test.	217
100%	197
50%	155
33 1/3%	125

Fig. 3 shows the cost of fuel with oil at 70c and also at $1.00 per barrel per switchboard kilowatt-hour as affected by the load factor and indicates clearly the increased cost of fuel resulting from a low average daily load.

I have used $1.00 per barrel as the cost of fuel, primarily for the reason that, if the fuel costs a greater or less amount it is quite convenient to find the exact fuel cost by taking a direct proportion between the actual cost and the figure given of $1.00 per barrel.

The curves of Fig. 3 show what is considered to be the maximum and minimum range of price for the cost of fuel oil, namely $1.00 per barrel for the former and 70c per barrel for the latter.

It must be noted in Mr. Weymouth's paper on Power Plant Economy from which these figures are taken that he is careful to state that, "The above figures are approximate only, and are subject to considerable variation, depending on operating conditions, etc.," and the oil is assumed as having a thermal value of 18,850 B.t.u. per pound, weighing 336 lb. per barrel.

In this connection it is also well to have it fully understood that the figures given for the two particular electric lighting systems, both as regards the investment in the different portions of the systems, and the resulting average costs per kilowatt-hour are to be considered as only relative and not as indicating absolutely the average costs per kilowatt-hour, especially as delivered to customers' meters, in other plants operating under decidedly different conditions as regards the cost of electric energy on the switchboard and character and extent of the complete installation, primarily in the distribution systems.

SYSTEM NO. 1.

Character of Generating Station	Steam Plant
Cost of fuel oil, per barrel	$ 1.00
Installed capacity	1,750 kw.
Peak load for year	1,200 kw.
Average load for year	415 kw
Load factor for year	34.6%
Efficiency of distribution system from switchboard to customers' meters	65%
Aggregate length, distribution system	75 miles
Average cost of distribution system per mile	$ 3,430
Number of customers	3,057
Number of customers per mile of distribution system	41
Number of pole transformers	552
Aggregate capacity transformers	2,179 kw.
Average capacity per transformer	4 kw.
Total valuation system	$ 560,000
Kw.-hr. steam plant switchboard per year	3,635,500
Kw.-hr delivered to customers' meters per year	2,363,000
Average generating cost per kw.-hr steam plant switchboard	1.91c
Average generator cost per kw.-hr. delivered to customers' meters	2.94c
Average total cost per kw.-hr. delivered to customers' meters	6.32c

SYSTEM NO. 11.

Chatter of Electric Service.	From water and steam power transmission system
Peak load for year	2,500 kw.
Average load for year	750 kw.
Load factor for year	33 1/3%
Efficiency of distribution system from switchboard to customers' meters	70%
Aggregate distribution system:	
Overhead	100 miles
Underground	4½ miles
Average cost disribution system per mile	$ 3,050
Number of customers	7,250
Number of customers per mile of distribution system	69
Number of pole transformers	424
Aggregate capacity transformers	4,167 kw.
Average capacity per transformer	10 kw.
Total valuation of system	$ 577,000
Kw.-hr. sub-station switchboard per year	6,570,000
Kw.-hr. delivered to customers' meters per year	4,600,000
Cost per kw.-hr sub-station switchboard:	
100% load factor	75c
20% load factor	2.25c
Cost at the sub-station switchboard per kw.-hr. delivered to customers: meters:	
30% load factor	3.21c
Average total cost per kw.-hr. delivered to customers' meters	6.34c

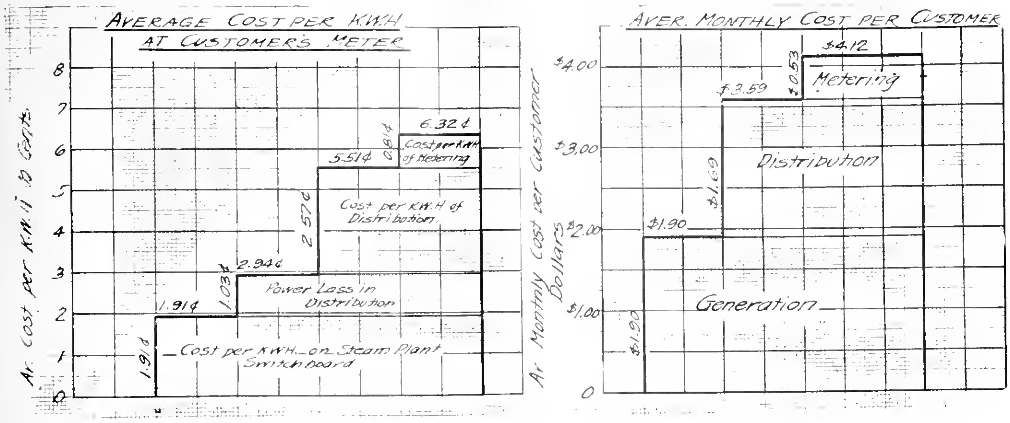


Fig. 1. Average Cost per kw.-hr. and Cost per Customer System No. 1.

SYSTEM NO. 1.

Investment in Generating Station, Distribution System, and Electric Meters Per kw. Installed Capacity, Peak Load, and Average Yearly Load.

		Investment per Kilowatt		
Portion of System.	Investment	Installed. Capacity.	Peak Load.	Average Load.
Generating station..	$253,000	$144.44	$210.65	$609.50
Distribution system.	257,000	146.90	211.17	619.00
Electric meters	50,000	28.55	44.63	120.50
Total	$560,000	$319.89	$466.45	$1,349.00

The relation between the investment per kilowatt in the generating stations, distributing system, and electrical meters, based on the peak load and the average load indicates clearly the disadvantage of a low load factor. When the total investment is as much as $1349 per kw. average load, and the investment in meters alone is $120.50 per kw. average load, it is easy to understand the causes of the higher fixed charges under such operating conditions.

SYSTEM NO. 1.

Annual Station Charges and Cost Per kw.-hr. on Switchboard and Customers' Meters for Different Load Factors.

Item.	%	Yearly total	Per Kilowatt Hour 100%	70%	35%
Interest	5%	$12,650	0.12	0.17	0.34
Taxes	1.6%	4,050	0.04	0.06	0.11
Depreciation	5%	12,650	0.12	0.17	0.34
Fuel			0.51	0.56	0.79
Operation and maintenance		12,000	0.11	0.16	0.33
Total generating cost per kw. at plant			0.90c	1.12c	1.91c
Total generating cost per kw. delivered to customers' meters			1.38c	1.73c	2.94c

In the above table the average rate of depreciation upon the generating station is taken at 5 per cent, which has been determined by considering separately the estimated life of the different parts of the station, including buildings, foundations, and the steam and electrical machinery. The total generating cost per kw.-hr. at the plant, it will be noted, is less than one-half as much at 100 per cent load factor as at 35 per cent load factor, the actual figures being 0.9c per kw.-hr., with the best character of load and 1.90c per kw.hr., with the average load a little more than 1/3 of the maximum of peak load.

SYSTEM NO. I.

Annual Distribution Charges and Cost Per kw.-hr. on Switch-Board and at Customers' Meters for Different Load Factors.

Item	%	Amount	Per Kilowatt-Hour. 100%	70%	35%
Interest	5%	$12,850	0.12	0.17	0.35
Taxes	1.6%	4,120	0.04	0.06	0.11
Depreciation	8½%	21,850	0.21	0.30	0.59
Maintenance and operation		23,000	0.22	0.31	0.62
Total distribution cost per kw.-hr. at plant			0.59c	0.84c	1.67c
Total distribution cost per kw.-hr. delivered to customers' meters			0.91c	1.29c	2.57c

In the above table the annual depreciation for the distribution system has been taken at 8½ per cent and has been determined by estimating the life of the different elements of the distribution system, including poles, cross-arms, transformers, conductors, and other outside construction materials.

It is to be noted in this table that the total distribution cost per kw.-hr. delivered to customers' meters is nearly three times as great at 35 per cent load factor as at 100 per cent load factor, or 0.257c per kw.-hr. in the former case and 0.091c per kw.-hr. under the most favorable operating conditions.

Annual Metering, Billing and Collecting, Etc., Charges and Cost Per kw.-hr. on Switchboard and to Customers' Meters for Different Load Factors.

Item	%	Amount	Per Kilowatt-Hour. 100%	70%	35%
Interest	5%	$2,500	0.02	0.03	0.07
Taxes	1.6%	800	0.01	0.01	0.02
Depreciation	8%	4,000	0.04	0.05	0.11
Maintenance and operation		12,000	0.11c	0.16c	0.33c
Total metering cost per kw.-hr. at plant			0.18c	0.25c	0.53c
Total metering cost per kw.-hr. delivered to customers' meters			0.28c	0.38c	0.81c

The total average cost per kw.-hr. delivered to customers' meters at 100 per cent, 70 per cent, and 35 per cent load factor in the above table, are, respectively 2.57c, 3.4c and 6.32 c, which comparative figures indicate clearly why the customer, using electrical energy, even though it is comparatively small in magnitude, is justly entitled to a decidedly low rate if the electric energy used by him is utilized at a high daily average

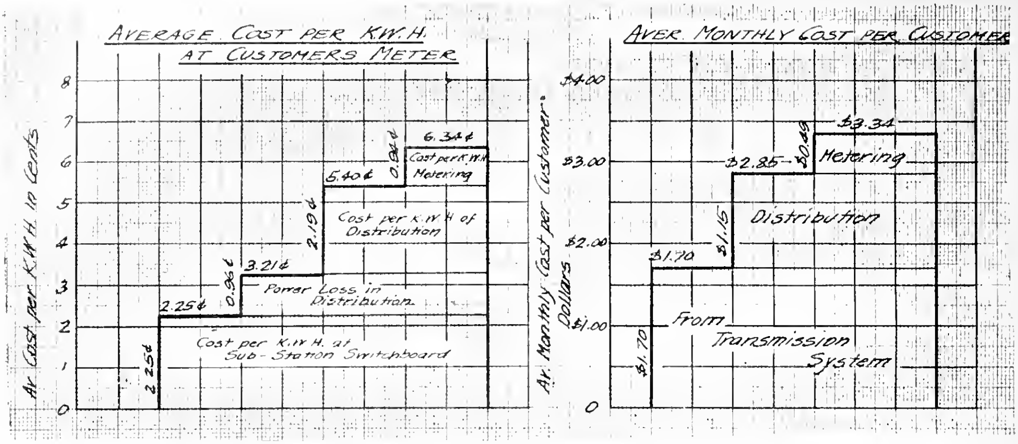


Fig. 5. Average Cost per kw.-hr. and Cost per Customer, System No. 2.

load, or in other words, if his demand for service is such that the load factor is high. In this instance, if the load factor is uniform throughout the 24 hours, his rate may properly be 2.57c per kw.-hr., increasing from this to 3.4c, if the average load is 70 per cent of the maximum, and finally to 6.32c if the average load is but 35 per cent of the maximum or peak load.

SYSTEM NO. I.

Total Cost of Electric Service Per kw.-hr. to Customers' Meters at Different Load Factors.

Item.	per Kilowatt-hour to Customer at 100%	70%	35%
Generation	1.38c	1.73c	2.94c
Distribution	0.91c	1.29c	2.57c
Metering	0.28c	0.38c	0.81c
Total cost (average)	2.57c	3.40c	6.32c

The figures in the last column are shown graphically in Fig. 4, which includes the average segregated cost of electrical service to customers in System No. I per kw.-hr. as well as the corresponding average monthly cost per customer. The average monthly bill in System No. I is $4.12, divided as follows.

Generation costs	$1.90
Distribution costs	1.69
Metering, billing, collecting, etc.	.53
Total	$4.12

It will be noted in the above that the cost of distributing the energy due to the fixed charges on the required investment, and losses in the distribution system and the comparatively low load factor, are not materially less than the corresponding cost of generating the electrical energy, while the cost of metering, billing, and collecting, per month, per customer, averages 53c, which is an indication at least of the necessity of a minimum bill whether current is used by the customer or not.

TOTAL INVESTMENT IN SYSTEM NO. II.

Substation—		
Real Estate	$22,000	
Buildings	33,500	
Apparatus	87,500	$143,000
Distribution—		
Overhead	$274,500	
Underground	44,000	318,500
Meters		115,500
Total		$577,000

SYSTEM NO. II.

Investment in Substation, Distribution System and Electrical Meters Per kw.-hr., Peak and Average Yearly Load.

	Total Investment	Investment per kilowatt. Peak Load 2500 kw.	Average Load 750 kw.
Substation	$143,000	$ 57.20	$190.60
Distribution	318,500	127.50	424.70
Meters	115,500	46.20	153.90
Total	$577,000	$230.90	$769.20

From the above figures it is to be noted that the total investment per kilowatt for the average load in System No. II is only a little more than one-half the corresponding investment in System No. I, this being due to the fact that there is no investment required for the generating station in System No. II. This is also shown in a rather striking manner by the fact that the total investment in System No. I for a peak load of 1200 kw. is $560,000, while the total investment in System No. II, not requiring a generating station, is but little more, or $577,000 for a peak load of 2500 kilowatts, or more than twice that of System No. I. This is true notwithstanding the fact that in System No. II there is a considerable portion of the distribution system underground, thereby requiring a relatively higher investment than for an overhead system of the same capacity.

SYSTEM NO. II.

Annual Distribution Charges and Cost per kw.-hr. on Switch-Board and at Customers' Meters for Different Load Factors.

Cost of distribution. Item.	Amount.	Per Cent.	Yearly Charge.	100 miles of distribution system. Cost per kw. hr. 100%	70%	30%
Interest	$461,000	5%	$23,050	0.11c	0.15c	0.35c
Taxes	461,000	1.6%	7,376	0.03c	0.05c	0.11c
Depreciation—						
Buildings	33,500	3%	1,005			
Electrical apparatus	87,500	5%	4,375			
Distribution: Overhead	274,500	8½%	23,333			
Underground	44,000	4%	1,760			
	$439,500	6.91%	$30,473	0.14c	0.20c	0.46c
Maintenance and operation			$10,000	0.18c	0.26c	0.61c
Total distribution cost per kw.-hr. at sub-station				0.46c	0.66c	1.53c
Total distribution cost per kw.hr. delivered to customers' meters				0.66c	0.94c	2.19c

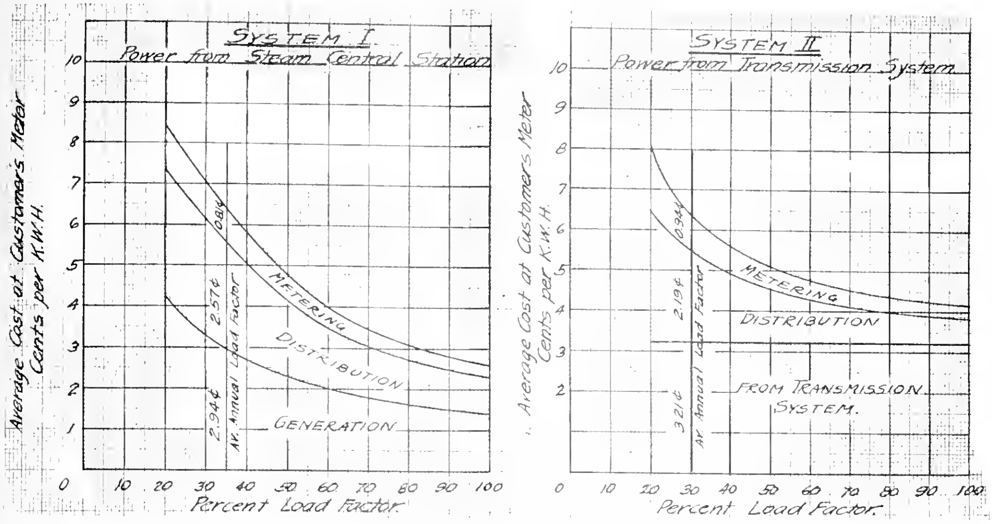


Fig. 6. Comparison of Power From Steam Central Station as Opposed to Power From Transmission System.

From the above table the distribution cost per kw.-hr. delivered to customers' meters at 100 per cent load factor—0.66c is less than 1/3 of the corresponding distribution cost at a load factor of 30 per cent, which clearly indicates the reason why rates for electric service for a low average load as contrasted with the maximum load, are materially higher than for a load approximating 100 per cent load factor.

SYSTEM NO. II.

Annual Metering, Billing and Collecting, etc., Charges, and Cost per kw.-hr. on Sub-Station Switchboard and at Customers' Meters for Different Load Factors.

Item.	Amount.	Per cent.	Yearly charge.	Cost per kilowatt hour. 100%	70%	30%
Interest	$115,500	5%	$ 5,775	0.03c	0.04c	0.09c
Taxes	115,500	1.5%	1,850	0.01c	0.01c	0.02c
Depreciation	115,500	7%	9,240	0.04c	0.06c	0.11c
Maintenance and operation			26,000	0.12c	0.17c	[illegible]
Total metering cost per kw-hr. at sub-station				[illegible]	0.28c	[illegible]
Total metering cost per kw.-hr. delivered to customers' meters				[illegible]	[illegible]	[illegible]

The figures of the above table have been used to show graphically, as per Fig. 5, the average segregated cost of electric service to customers in System No. II per kw.-hr., and also per month. In this system the cost of electric energy from the transmission lines represents an average monthly cost to customer of $1.70. The corresponding distribution cost, $1.15 and the metering, billing and collecting 49c, or a total average monthly cost per customer of $3.34. The average cost per kw.-hr. at customers' meters is practically the same in System No. I and in System No. II, namely, 6.32c and 6.34c, respectively. The corresponding average monthly cost per customer is considerably less in System No. II, than in System No. I, as a result of the greater number of meters, or customers in the latter case.

Fig. 6 shows for both systems the variation of the generation cost, in the one case, and the cost of electrically transmitted power in the other, and for both cases, the distribution and metering costs per kw.-hr average to customers' meters at different load factors. The effect upon the rate per kw.-hr at low load factors and the necessity of increasing this rate in such cases is clearly shown by the curves for both systems.

SYSTEM II.

Total Cost of Electric Service per Kilowatt-Hour to Customers' Meters at Different Load Factors.

Item	Cost per Kilowatt-Hour at Customers. 100%	70%	30%
Cost of power at sub-station	1.07c	1.50c	3.21c
Distribution	0.66c	0.94c	2.19c
Metering	0.26c	0.40c	0.94c
Total	2.01c	2.84c	6.34c

Annual and Monthly Costs per Customers.

SYSTEM NO. I.

	Per year.	Per month.
Average cost of electric energy at steam plant switchboard per customer	$22.71	$1.90
Average cost of electric distribution per customer	20.22	1.69
Average cost of metering, billing and collecting per customer	6.31	0.53
Combined cost of electric distribution, metering, billing and collecting per customer	26.53	2.22

SYSTEM NO. II.

	Per year.	Per month.
Average cost of electric energy at sub-station switchboard per customer	$20.39	$1.70
Average cost of electric distribution per customer	13.91	1.15
Average cost of metering, billing and collecting per customer	5.90	0.49
Combined cost of electric distribution, metering, billing and collecting per customer	19.81	1.64

In the determination of costs as given above, interest has been assumed as 5 per cent on the investment corresponding approximately to the interest charge on investments made by municipalities as a result of bond issues. Taxes have been considered at 1.6 per cent per annum, corresponding to an assessment of 50 per cent on the valuation and a tax rate of $3.20 per $100 assessed value.

If the return upon the investment is assumed as that to which a privately owned public service corporation, furnishing electric light and power to the inhabitants of a city, is entitled, as per the decis-

ions of the Wisconsin Railroad Commission in the case of the State Journal Printing Company vs. The Madison Gas & Electric Company, page 648 W. R. C. R. Vol. 4, namely 8 per cent and the taxes are assumed as equivalent to those actually paid by the company owning System No. I, kw.-hr. on the basis of 4 per cent of its gross receipts the corresponding costs per kw.-hr. at 35 per cent load factor, would be as follows:

SYSTEM NO. I.

Generating costs per kw. at plant	2.16c
Generating costs per kw. delivered at customers' meters	3.33c
Distribution costs per kw.-hr. at plant	1.91c
Distribution costs per kw.-hr. delivered to customers' meters	2.94c
Metering costs per kw.-hr. at plant	0.53c
Metering costs per kw.-hr. delivered to customers' meters	0.89c
Total costs per kw.-hr. delivered to customers' meters	7.16c

If the return upon the investment is assumed at 8 per cent and the taxes equivalent to those paid under the California law, of 4 per cent of the gross receipts the corresponding costs per kw.-hr. at 30 per cent load factor would be as follows:

SYSTEM NO. II.

Cost per kw.-hr. at sub-station switchboard	2.25c
Sub-station cost per kw.-hr. when delivered to customers' meters	3.21c
Distribution costs per kw.-hr. at sub-stations	1.78c
Distribution costs per kw.-hr. delivered to customers' meters	2.54c
Metering costs per kw.-hr. at sub-stations	.72c
Metering costs per kw.-hr. delivered to customers' meters	1.03c
Total costs per kw.hr. delivered to customers' meters	6.78c

Comparative Cost per Kilowatt-Hour, First, With Return on Investment 5%, Taxes 1.6%, and Second, Return on Investment 8% and Taxes 4% Gross Receipts.

SYSTEM NO. I.	Return. 5%	Return. 8%
Generating cost per kw.-hr. at plant	1.91c	2.16c
Generating cost per kw. hr. delivered to customers' meters	2.94c	3.33c
Distribution cost per kw.-hr. delivered to customers' meters	2.57c	2.94c
Metering cost per kw.hr. delivered to customers' meters	0.81c	0.89c
Total average cost per kw.hr. delivered to customers' meters	6.32c	7.16c

SYSTEM NO. II.	Return 5%	Return 8%
Cost per kw.-hr. at sub-station switchboard	2.25c	2.25c
Sub-station per kw-hr. delivered to customers' meters	3.21c	3.21c
Distribution cost per kw.-hr. delivered to customers' meters	2.19c	2.54c
Metering cost per kw.hr. delivered to customers' meters	0.91c	1.03c
Total average cost per kw.-hr. delivered to customers' meters	6.34c	6.78c

It must be most clearly borne in mind that the above figures refer to the average cost per kilowatt-hour, as delivered to customers' meters, and have no direct relation to the maximum rate per kilowatt-hour to be charged some customers, or in a similar manner the minimum rate, or any rates between the maximum and minimum rates. This is manifest because every customer who requires for his service an investment and maintenance and operating charge in the cost of electric power at the substation and steam plant, or excessive expenses connected with distribution due to the small amount of current used or the comparatively high investment required to reach him in the distribution system; or as a result, also of the low load factor, must pay a rate in excess of the average cost per kilowatt-hour delivered to customers' meters, while other customers using greater quantities of electrical energy at a decidedly higher load factor than the average, with a comparatively smaller investment in the distributing system and meters, should in equity be given a rate per kilowatt-hour decidedly less than the average cost as delivered to customers' meters.

THE RANKINE CYCLE AND ENTROPY TABLES.[1]

BY ROBERT SIBLEY

Before proceeding further with the thermodynamic laws acting in the steam engine cylinder and their application in engineering practice, we come now to the important consideration of the socalled Rankine cycle and entropy.

In rules drawn up by the American Society of Mechanical Engineers for conducting steam-engine tests, it is recommended that the ratio of economy of the engine under test be compared to that of an ideal engine. The ideal engine is one which follows the Rankine cycle where steam at constant pressure is admitted into the cylinder with no clearance, and after the point of cut-off, is expanded adiabatically to the back pressure. In obtaining the economy of this engine, the feed water is, of course, assumed to be returned to the boiler at the exhaust temperature.

In our last lecture we discussed certain laws of expansion and had for our consideration an illustration of a cycle of operations as shown in the diagram of Fig. 28. A study of the particular equations that express the curves which form the boundaries of a cycle of such operations has led to many practical and useful results.

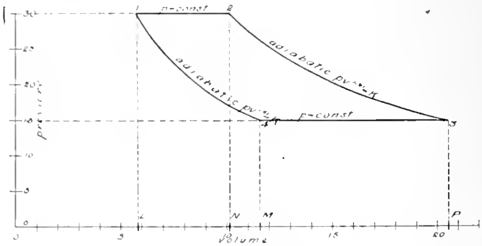


Fig. 29 The Rankine Cycle.

Thus, let us assume that our cycle starts out with a constant pressure line from 1 to 2; then continues by an adiabatic from 2 to 3; again being compressed along a constant pressure line, it returns along the line from 3 to 4 and along an adiabatic line from 4 to 1. Such a series of operations is known as a Rankine cycle and is shown in Fig. 29. This cycle as we have seen is what takes place in the ideal steam engine. For our present consideration we shall use air instead of steam, however. The quantity n in the equation $pv^n = K$, has 1.41 for its value in the case of air as we have previously seen.

Again, if our series of expansions are made up, first of an isothermal, then an adiabatic and our compressions first of an isothermal and then an adiabatic such as is shown in Fig. 30, we have the well-known Carnot cycle.

In our last lecture we found that as the gas expanded from 1 to 2, heat must be supplied and that this heat in general performed two functions, first it raised the temperature of the gas and second it caused

[1]This paper comprises the Thirteenth Lecture of the series appearing in these columns entitled "Primer of Applied Thermodynamics," which is a resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Mechanical Engineering students at the University of California.

the gas to perform external work. One of the most important conclusions found was that the area 12 N L represented this work. It easily follows, then, that the area 23 P N is the work performed by the gas in expanding from 2 to 3, 34 M P the work done upon the gas in compressing it from 3 to 4 and 41 L M the work done upon the gas in still further compressing it from 4 to 1. Hence the net work done by the gas is evidently the area in the enclosure 1234. This is a most important result and the ground-work for all indicator card representations. For it is evident that if we compute the area enclosed on an indicator card we can figure the work performed by allowing for proper scale reduction in stroke and pressure.

As engineers, however, we are interested not alone in the amount of work performed, but also in the amount of heat it has been necessary to supply to the gas in order to perform this work. Looking again at Fig. 30, we see plotted at 1 a gas which has a definite volume, temperature and pressure. We found under a discussion of adiabatic expansion in our last lecture that when a gas expands adiabatically—that is, without taking heat from an external source it will continue to do work at the expense of lowering its temperature until the temperature has been reduced to the absolute zero. Thus if its temperature is reduced from T_1 to T, the gas in expanding adiabatically would do an amount of work equal to $\frac{R}{0.41}(T_1 - T)$. If now,

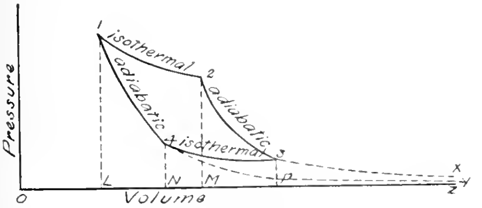


Fig. 30. The Carnot Cycle.

T becomes reduced to zero, the greatest amount of work we can possibly hope for under most ideal conditions would be $\frac{R}{0.41}T_1$. Hence the area 14 Y Z L is the total quantity of heat reservoired in the gas at 1. Now when heat is supplied and the gas expands to 2, it has a new reservoir of energy similarly computed and equal to 2 X Z M and since it has done work equal to 12 M L, evidently the necessary heat to be supplied to accomplish this must be represented by the area 12 X Y 4. In other words the heat supplied between two points is always represented on a pressure-volume diagram by area between the curve connecting the two points, the two adiabatics drawn through these points and extended infinitely to the right of the expansion line.

It is evident, however, that such a diagram is not practical as we can not measure with any known instrument an area extending infinitely beyond our diagram. The necessity early became apparent to engineers to devise some other form of diagram that would correctly represent the heat supplied and that could be readily computed with ordinary area measuring instruments. As a consequence the socalled T N or temperature-entropy diagram was invented. Let us cast about and see if we cannot invent some diagram to correctly represent the heat supplied. Let us choose absolute temperatures for vertical distances or ordinates and let us call the horizontal distances a new quantity—say call it entropy. These horizontal distances must be of such a nature that the area enclosed between the curve, the entropy axis and any two temperature ordinates will always represent the heat supplied, in changing the state of the gas from the first temperature to the second. Fig. 31 shows the appearance of our Carnot cycle shown in Fig. 30 on a temperature-entropy diagram. Thus, since in going from 1 to 2 on a Carnot cycle our gas expands on an isothermal or equal temperature curve the straight horizontal line 1 2 will represent correctly the first expansion and the area 12 M L the heat supplied. Since the gas continues to expand next from 2 to 3 along an adiabatic or no heat supply curve no area must be shown, hence a downward straight line to 3 correctly represents this line. Again under compression the lines 34 and 41 are similarly traced, and the area 1234 represents, then, the net heat supplied. It is shown in works on calculus that when a gas expands isothermally—say from 1 to 2 in Fig 31, the horizontal distance on the curve or entropy is coumputed from the expression $R \log_e \frac{V_2}{V_1}$.

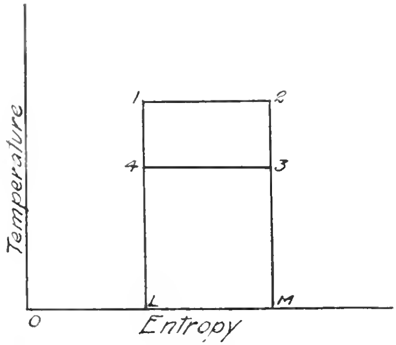


Fig. 31. A Typical Temperature Entropy Diagram for the Carnot Cycle.

By referring to the figure it is also seen that in going from 1 on the adiabatic line 14 L it makes no difference whether we wind up at 2, 3 or any other point on the adiabatic line 23 M the distance L M or the entropy is the same. This has most important applications in the steam engine and the steam turbine operation. Thus, it is shown in works of calculus that the entropy of a liquid which Peabody desiguates in his tables as θ is equal to $\log_e \frac{T_2}{T_1}$, and the entropy of a vapor $\frac{L_1}{T_2}$ in which $\log_e$ is the natural system of loga-

rithms, which is computed by multiplying our ordinary logarithms by 2.306, T_2 the absolute temperature of the saturated steam, T_1 is the absolute temperature of 32° F., and L the latent heat of the saturated steam.

STEAM AND ENTROPY TABLES.

We are now ready to fully understand all the data contained in the standard tables on steam and entropy. Fig. 32 shows a page from Peabody's Steam and Entropy Tables while Fig. 33 shows a similar page from Steam Tables and Diagrams by Marks and Davis. These two books constitute standard engineering practice and it will consequently be well worth our while to see what the different columns mean and how they have been computed.

Let us take Fig. 33 for example and examine the line for 231° F. Under p we have pressure in lb. per sq. in. This of course is in absolute pressures and if a steam gauge has been read to ascertain boiler pressure we must add 14.7 lb. or atmospheric pressure to our gauge reading in order to convert into absolute pressure units shown in this column. The next column is headed atmospheres. 14.696 lb. per sq. in. is equal to one standard atmosphere of pressure. Hence simply divide p by 14.696 and we obtain reading under this column, which in this case is

$$\frac{21.16}{14.696} = 1.440.$$

Under the next column headed v or s, we have the cubic ft. occupied by 1 lb. of saturated steam at this particular temperature of 231° F. This is computed from the following thermodynamic law:

$$L = T\left(\frac{\Delta p}{\Delta t}\right)(v - v_1)$$

40 SATURATED STEAM—TABLE I.

Temperature, Degrees Fahrenheit t	Pressure, Pounds per Square Inch. p		Heat of the Liquid q	Heat of Vaporization r	Heat Equivalent of Internal Work ρ	Heat Equivalent of External Work Apu	Entropy of the Liquid θ	Entropy of Vaporization $\frac{r}{T}$	Specific Volume, Cubic Feet per Pound s		Density, Pounds per Cubic Foot $\frac{1}{s}$		Temperature, Degrees Fahrenheit t
228	20.02		196.5	959.4	885.1	74.3	0.3363	1.3955	20.07		0.04983		228
		38								35		87	
229	20.40		197.5	958.7	884.3	74.4	0.3378	1.3925	19.72		0.0507		229
		38								35		9	
230	20.78		198.5	958.1	883.6	74.5	0.3392	1.3895	19.37		0.0516		230
		39								33		9	
231	21.17		199.5	957.4	882.8	74.6	0.3407	1.3866	19.04		0.0525		231
		40								33		9	
232	21.57		200.5	956.8	882.1	74.7	0.3422	1.3836	18.71		0.0534		232
		40								32		10	
233	21.97		201.5	956.1	881.3	74.8	0.3436	1.3806	18.39		0.0544		233
		41								31		9	
234	22.38		202.5	955.4	880.6	74.8	0.3451	1.3777	18.08		0.0553		234

Fig. 32. A Leaf From Peabody's Steam and Entropy Tables.

in which L is the latent heat determined by experiment, which is seen to be 958.7 B.t.u., or 958.7 × 777.5 ft.. lbs., T is the absolute temperature in this illustration and is 231 + 459.6 = 690.6, Δp is the increase in pressure in lb. per sq. ft. from 230° to 232° or the increase for $\Delta t = 2$ and is seen to be 21.56 × 144 — 20.77 × 144 = .79 × 144, v is the unknown quantity desired and v_1 is the volume in cubic ft. occupied by one lb. of water, which is .016 cu. ft. Hence substituting

$$958.7 \times 777.5 = 690.6\left(\frac{.79 \times 144}{2}\right)(v - 0.16)$$

$$\therefore v = \frac{958.7 \times 777.5 \times 2}{690.6 \times .79 \times 144} + .016 = 19.05$$

The next column is the specific density of saturated steam or the weight of 1 cubic ft. of saturated steam at 231° F. It is evident that since 19.05 cu. ft weigh 1 lb., then

$$\text{Density} = \frac{1}{v} = \frac{1}{19.05} = 0.0525 \text{ lb.}$$

Under the column headed heat of liquid, known as h or q, we have the amount of heat required to raise one lb. of water from 32° F. to the particular temperature under consideration. This has been determined by experiment. Evidently if exactly 1 B.t.u. per degree was required, 199 B.t.u. would be necessary. As touched upon in preceding lectures, however, it requires slightly more than this or 199.2 B.t.u. in this instance.

The L or r column is seen to be the latent heat of evaporization which is experimentally determined and in this case equal to 958.1 B.t.u. The total heat column H is the sum of the data in the h and L column and in this case is seen to be 199.2 + 958.1 = 1157.3 B.t.u.

Table 1: Temperatures

Temp. Fahr. t	Pressure lbs. p	Pressure Atmos* —	Sp Vol cu ft. per lb. v or s	Density lbs. per cu. ft. 1/v	Heat of the liquid h or q	Latent heat of evap. L or r	Total heat of steam H	Internal Energy B.t.u Evap. I or ρ	Internal Energy B.t.u Steam E	Entropy Water n or θ L	Entropy Evap. T or r/T	Entropy Steam N or φ	Temp. Fahr. t
230°	20.77	1.413	19.39	0.0516	198.2	958.7	1156.9	884.3	1082.4	0.3384	1.3905	1.7289	230°
231	21.16	1.440	19.05	0.0525	199.2	958.1	1157.2	883.6	1082.7	0.3399	1.3875	1.7274	231
232	21.56	1.467	18.72	0.0534	200.2	957.4	1157.6	882.8	1083.0	0.3414	1.3844	1.7258	232
233	21.96	1.494	18.40	0.0543	201.2	956.7	1158.0	882.1	1083.2	0.3429	1.3814	1.7243	233
234	22.37	1.522	18.09	0.0553	202.2	956.1	1158.3	881.3	1083.5	0.3443	1.3784	1.7227	234
235°	22.79	1.550	17.78	0.0562	203.2	955.4	1158.7	880.6	1083.8	0.3458	1.3754	1.7212	236°
236	23.21	1.579	17.47	0.0572	204.2	954.8	1159.0	879.8	1084.0	0.3472	1.3725	1.7197	236

Fig. 33. A Leaf From Steam Tables and Diagrams by Marks and Davis.

In evaporating water into steam the socalled latent energy is expended in two ways, a part of it goes toward overcoming internal work in the molecular arrangement of the steam itself, and a part in overcoming external work caused by the enormously increased volume of the steam. Since this latter work can never be recovered in the use of steam expansively, it is of utmost importance for us to be able to segregate these two quantities and note under this column the internal work only as we may expect this portion for useful applications in the steam engine and the steam turbine. We have seen in the last lecture that external work is computed by taking a product of pressure and increase in volume. Hence

$$\text{External work in B.t.u.} = \frac{p\,(v - v_1)}{777.5}$$

$$= \frac{144 \times 21.16\,(19.05 - .016)}{777.5} = 74.6$$

$$\therefore \rho = 958.1 - 74.6 = 883.5$$

The total net energy that we may reasonably expect to use in engineering applications is the sum of this internal energy of evaporization and the heat of the liquid which is shown under the next heading entitled E.

$$E = h + \rho = 199.2 + 883.5 = 1082.7.$$

Under the next heading we find entropy of water which we have seen is

$$\theta = \log_e \frac{T_2}{T_1}$$

in which $T_2 = 231 + 459.6 = 690.6$, $T_1 = 32 + 459.6 = 491.6$,

$$\therefore \theta = \log_e \frac{690.6}{459.6} = 2.306\,[\log_{10} 690.6 - \log_{10} 459.6] = 0.3399$$

	Meters per sec.	Centimeters hydraulic depth.			Rough empirical equations.	Formula normal equations n			Formula normal equations m		
No.	v	r	log v	log r	a b c	a b	b^2	b c	a c	b c	c^2
1	1.73	11.4	0.238	1.057	0.238 = 1.057 n + log m	.252	1.117	1.057	0.238	0.057	1
2	1.98	14.4	0.297	1.158	0.297 = 1.158 n + log m	.344	1.340	1.158	0.297	1.158	1
3	2.17	17.0	0.336	1.230	0.336 = 1.230 n + log m	.413	1.513	1.230	0.336	1.230	1
4	2.33	19.2	0.367	1.283	0.367 = 1.283 n + log m	.471	1.647	1.283	0.367	1.283	1
5	2.46	21.2	0.391	1.326	0.391 = 1.326 n + log m	.518	1.758	1.326	0.391	1.326	1
					Total .	1.998	7.375	6.054	1.629	6.054	5.000

Solution of Darcy & Bazin Experiment (See Thermotwister No. 1.)

The entropy of evaporation is as we have previously seen simply $\frac{L}{T}$ or in this case

$$\frac{L}{T} = \frac{958.1}{690.6} = 1.3875$$

Hence the final column being the total entropy of saturated steam is

$$\theta + \frac{L}{T} = 0.3399 + 1.3875 = 1.7274$$

Thermotwisters.

1. Take Fig. 32 which gives a page from Peabody's Steam and Entropy Tables and connect up all computations for each column as was done in this lecture for Fig. 33.

2. Work out for yourself an example in applying the temperature-entropy diagram by transforming the Carnot cycle shown in Fig. 30 on the pressure-volume diagram to the temperature-entropy coordinates.

SOLUTION OF THERMOTWISTERS—HOW TO MAKE UP EMPIRICAL FORMULAS.

1. Darcy and Bazin experimenting on the flow of water compiled the following experimental data:

No. of exp.	1	2	3	4	5
Mean velocity (v)	1.73	1.98	2.17	2.33	2.46
Hydraulic radius (r)	11.4	14.4	17.0	19.2	21.2

Assuming that the velocity of water in channels is of the form of $v = m r^n$, show that $v = 0.446\, r^{0.55}$ is an empirical formula for compiling the mean velocity.

$v = mr^n$. By taking logarithms, we have

$$\log v = n \log r + \log m$$

Hence the two normal equations are

$$1.998 = 7.375\, n + 6.054 \log m$$
$$1.629 = 6.054\, n + 5.000 \log m$$

Solving for n and log m, we have

$$n = 0.571$$
$$\log m = 0.366 = \bar{1}.634 \qquad \therefore m = 0.431$$
$$\text{or } \log v = 0.571 \log r - 0.366$$
$$\therefore v = 0.431\, r^{0.571}. \quad \text{Ans.}$$

2. In a steam engine it is found that after cut-off takes place the pressures and volumes during expansion of the steam have the following values:

60 lb. absolute press. corresponds to 7.107 cu. ft.
50 " " " " " 8.429 cu ft.
40 " " " " " 10.39 cu ft.

Assuming the steam expands according to the law $p v^n = K$, where n and K are constants, determine their value.

Having assumed $pv^n = K$, we have taken logarithms on both sides.

$$\log p + n \log v = \log K = K'$$
$$\text{or } \log 60 + n \log 7.107 = K'$$
$$\log 50 + n \log 8.429 = K'$$
$$\log 40 + n \log 10.39 = K'$$

$$\text{or } 1.778 + 0.852\, n = K' \qquad 1.514 + 0.725\, n = 0.852\, K'$$
$$1.699 + 0.925\, n = K' \qquad 1.573 + 0.857\, n = 0.925\, K'$$
$$1.602 + 1.017\, n = K' \qquad 1.629 + 1.034\, n = 1.017\, K'$$

Summary coefficients:

$$5.079 + 2.794\, n = 3\, K' \quad (A) \qquad 4.716 + 2.616\, n = 2.794\, K' \quad (B)$$

Solving for n in equations A and B, we find $n = 1.07$.

THE FUTILITY OF TECHNICAL SCHOOLS.

BY R. T. CRANE.[1]

To the subject of higher schools, in all their departments, I have given much study for many years, and while I consider them all to be full of errors, deception and ignorance, the technical institutions are particularly misunderstood, and concerning them the people need to be enlightened.

This misconception of their value and importance is quite natural, as the whole subject is shrouded largely in mystery, since science is so largely connected with it, and concerning anything with which science is associated the masses have no correct opinion. They imagine that as science in the past has played an important part in the progress of civilization, this also must be the case today, which is not a fact.

What Is Science?

At the outset let me state just what I mean by "science." The dictionary definition is very long, unsatisfactory, and, in my opinion, inconsistent with the general understanding of the word.

From my view-point "science" means the doing of things in a more or less highly intellectual way by taking advantage of natural laws and principles. Take, for example, the wheel in a wheelbarrow; the lever; the block and tackle; braces and truss-building and making of caissons, etc., etc. These are some of the things that I consider to be scientific, and I believe the general public will accept this definition.

Therefore, it will be seen that many scientific principles, while exceedingly numerous, are also exceedingly simple; in fact, most of them are so considered by a good mechanic. Notwithstanding this, however, the great mass of the unthinking public seem to be overwhelmed when anything is referred to as being scientific, and to think this means it is beyond their comprehension. Hence, the great reverence they have for technical schools and for men who specialize in scientific facts as they imagine such institutions are full of these mysterious matters.

Facts.

Now, here are some facts:

First: Comparing this country today with fifty years ago; it has gone to the greatest extreme in all kinds of technical schooling. In the United States today there are 129 technical institutions including universities that have a special department devoted to this branch of schooling, and the number of students taking this course of study is about 30,000, which in all probability means that about 10,000 boys are leaving these schools each year. From this we see that there would have to be an enormous demand in order to provide places for this large number

[1]Founder and President of Crane Co., Chicago.

of young men supposed to be trained for the higher and better positions.

Secondly: It is also a well known fact that this country was immensely successful before the technical schools were established.

Thirdly: Notwithstanding many educators are trying to make us believe that this country is going to destruction through dry rot and that the only means of saving it is through their schools, the fact is that no country on the face of the earth today is more prosperous or stands so high in everything in which technical schools are pretending to aid us as the United States.

Fourthly: All the heads of these technical schools, as well as all employers who claim to favor boys from such schools, admit that before such boys can be of any value in any line of business they must have a large amount of practical training.

Fifthly: Although tens of thousands of technically school trained men have been coming from these institutions, this class of men are doing little or nothing to contribute to the real prosperity of the country, and if you should go through our great industrial institutions you would find little trace of them in any important positions; probably not in one per cent.

Importance of Experience.

What a manufacturer wants is not a man of theory, but a man of brains who has had an immense amount of experience, who knows the state of the art thoroughly, and who understands all kinds of tools and what they are capable of doing. This is the only kind of a man that is of any account in a manufacturing business.

Hence we regard these schools as absolute failures, so far as being a help to general manufacturing and industrial business is concerned, and therefore it is not necessary to discuss this feature of technical school work.

Electrical Engineering.

Having now finished my talk, so far as it relates to technical schools and mechanics or manufacturing, I will take up the question of the utility of these schools in connection with the electrical line of work, which, if anywhere, would seem to be a feature of schooling wherein these technical institutions would be much more likely to produce good results.

On this subject I am fortunate in obtaining a copy of a paper by Mr. W. M. Alexander, of the General Electric Company, in which he discusses the question of the utility of technically school trained boys in their business, and he admits, as I have previously stated, that after having employed hundreds of these boys, he finds that his method of handling them heretofore has proved a failure and he has now concluded to try a radically different one.

Mr. Alexander now sees all sorts of short-comings in the technical school boys, stating that they have a speaking acquaintance only with machines and materials, that they have no ideas as to values, etc. He also volunteers the information that other large employers who have tried the college boys in their business have had a similar experience. No doubt he has reference to the Westinghouse and Western Electric companies, as both are very large concerns and are in much the same line of business as the General Electric Company.

These three companies have been taking a very large proportion of the boys from the technical schools who secure positions upon leaving these institutions, and in view of the facts disclosed by Mr. Alexander, you can see what a frightful blunder has been made. This gentleman has a great deal to say on this whole subject, and as his paper is very interesting, I reprint at the close of this pamphlet that portion of it which relates to this particular question.

Since the utter folly of trying to make electrical engineers in this way has been shown by the testimony of one who has been an earnest advocate of the technically school trained electrical engineer, and who, after a long and extensive experience with the boys of the technical schools, has became convinced that they are utterly lacking in merit, it is unnecessary to continue the argument further.

Common Sense Method of Making Electrical Engineers

The common sense way to make electrical engineers is as follows:

Select, with the greatest care, boys about 16 or 17 years of age for machine shop apprentices. Watch over them carefully in the first instance to see that they are what the employers are seeking as material for good machinists. If the foreman who keeps close eye on the boys discover that some of them have unusual ability, let such be put in the line of direct training for electrical engineering. Such boys, after having two years of training in the machine shop (say one year at bench work and a year at tool work), shifting around considerably, would get the knowledge of that part of the work which is required to make of them good electrical engineers. Then let them spend six months in the testing department, six months drafting, a year in the erecting department and a year in the operating department.

While working in this way they are surrounded constantly by an electrical atmosphere and will absorb, through observation and association, nine-tenths of all the knowledge they will need to have regarding electricity, and all this will have a splendid influence over them. The grandeur of the work is particularly inspiring, and the absorbing of all this information takes none of their time, as it is done unconsciously.

During this period the boys could attend night school as much as is necessary and be furnished books on the science of different lines of electrical apparatus, books containing only such things as the best practical men know to be essential. If necessary, lectures could be given advantageously by the company's own engineers who know decidedly better what these boys require than any school teacher could possibly know.

This would make five years in all, and then you would have a young man who, at 21 or 22 years of age, would be a fairly good electrical engineer. Such a man is likely to make his mark and certainly should be of considerable value to any one requiring his services. Besides this, he would have been earning his living all this time.

Great Electrical Engineers.

Before leaving this feature of the subject, let me call your attention to the fact that none of the greatest electrical engineers this country has had ever saw the inside of a technical school where electricity was taught. I shall not undertake to name all of these men, but among the list will be found Edison, Sprague, Brush, Rice, Westinghouse, Thomson and Hueston.

This being the fact, is it not perfectly clear that the very best kind of electrical engineers can be produced by following the plan just outlined? In other words, this is the distinction between theory and common sense, or between higher schooling and higher education.

College Authorities Sharp-Practice Men.

As you grow older you will discover that there are many kinds of sharp-practice men, each of whom has his own way of bleeding and defrauding the people in order to make his money, that is, to steal your money. The man who picks your pocket, the man who robs you, the burglar who enters your house, or the trusts that are mulcting you on every side are all decidedly vicious, but they are insignificant thieves compared with the man who induces you to spend your money and eight or ten of the best years of your life in acquiring something that will be of little or no value to you. You can overcome, perhaps, the loss of the money which these things have robbed you of, but you cannot afford to be robbed of the years which should be employed in laying the foundation of your future career by which you can support yourself and family.

In Conclusion.

Criticisms upon my method of dealing with this subject have been made, and there comes to me a recent instance of a young man of fine character and excellent home training, who, in an unguarded moment, while in the employment of the postoffice department in Chicago, took one dollar from a letter, and was sent to the penitentiary for one year.

If it was justice to punish this young man by committing him to the penitentiary for his act, what should be done to the people who are using every possible effort to induce boys to spend eight of the best unfolding years of their lives in securing a training which will be of no practical value to them in later years?

Therefore, I have no apology to offer for what any one may call the harshness of my views.

INVESTIGATION OF CORPORATION EDUCATIONAL CLUBS IN NORTHWEST[1]

BY JOHN B. FISKEN.

The only two companies reporting any steps looking toward the education of their employees, or clubs for their benefit, are the Portland Railway, Light & Power Company and The Washington Water Power Company.

The Portland Railway, Light & Power Company state that for a number of years past it has been the policy of the company to have regular monthly meetings of station operators in order that subjects concerning the operation of the various stations might be discussed in general so that each man might become thoroughly familiar with the system. Such subjects are taken up as will be of special interest to station men and will apply to their work, and of course the purpose of these meetings is to instruct the men as much as possible and arouse their interest in their work. It has recently been decided to enlarge the scope of these meetings somewhat and include not only the station operators but also men in the underground department and in the line department.

The Washington Water Power Company has furnished and maintains a technical library, located in the main office building, for the use of all its employees. A regular librarian is employed. At the present time the library contains about 550 volumes and 900 pamphlets and catalogues. Thirteen technical journals are received regularly and placed on file.

A club has been organized of all employees interested in line work construction and maintenance. Meetings are held twice a month, when papers on various subjects are presented and discussed.

One of the main objects of the association is to remedy faulty construction and to arrange for the adoption of forms of standard construction. To this end a committee on "Standard Construction" reports at every meeting and its recommendations are carefully discussed and gone over before adoption.

The company makes a practice of advancing their workmen as their knowledge of the work warrants, as for instance in line work. When a groundman has acquired the ability to climb he is advanced to the rank of a third class lineman, climbing short poles and doing work which does not require an experienced workman. As he gains proficiency, he becomes a second class lineman, climbing any size pole and doing any work, with the exception that he does not work on "live" lines, except when helping a first class lineman. The highest class is a first class lineman, who does any kind of line work including working on "live" lines up to 4000 volts.

An Aid Department is maintained by the employees of the company, whereby the members are given medical or surgical attention in case of illness or accident. It is governed by a board of managers, of which the general manager of the company is ex officio, a member and chairman. The superintendent of the street railway system, superintendent of the light and power system and the treasurer of the company are ex officio members. The board is composed of seven members, elected annually from the various departments, who hold office for one year. The department is supported by dues paid by all officers and employees of the company pro rata according to their monthly compensation.

The Seattle Electric Company have a technical club amongst its employees, which meets at regular intervals in a hall provided and furnished for the purpose, and connected with this hall, maintain a library and laboratory.

[1]Abstracted from a paper presented before the Northwest Electric Light & Power Association, Spokane, Wash.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Proposed Interurban in Northwest

Several items of interest have recently appeared in the news column of the Journal regarding the proposed electric line across the Flathead Indian Reservation in Montana. This reservation was thrown open for settlement some two years ago. Only those who have travelled in person across this beautiful fertile valley, hemmed in by protecting mountains, can appreciate the exquisite beauty of it all.

Two cities of promise in Western Montana have long since cast jealous eyes at each other as to which one would hold the key to the development of this promising country. Missoula on the south has completed an electric service to two of her suburban resorts and flirted with a forty mile extension still further southward in order to develop the land of the McIntosh red apple which reaches its greatest development in this famous section, known as the Bitter Root Valley.

Of course such projects as this Flathead Indian Reservation line or even the Bitter Root Valley extension can not under any possible estimation of present population or tonnage carried be shown as an actual dividend-payer. Any city, however, that will doze away while an empire in embryo as fruitful and as large as the whole of Japan awaits enterprising development, is liable to awake some day, like Rip Van Winkle, to see the progress but only to realize others have long since taken possession of the march of progress.

Rate Fixing

The data found elsewhere in these columns regarding the fixing of rates for electrical lighting in two typical Pacific Coast cities is interesting. It represents the application of the rulings of the well-known and thoroughly admired Wisconsin Railroad Commission applied to western municipalities.

A careful consideration of the data presented by Professor Cory in this excellent article brings out a very interesting point; namely, that a proper and equitable distribution of charges should not only take into account the load factor or proportion of power actually used by the consumer to the maximum demand he may to the limit of the capacity of his installation at any time make upon the power company, but the time of day during which such demand is made, is of utmost importance. The old saying of "sheep follow sheep" seems to be thoroughly in keeping with power consumption. Everybody seems to want light about the same two hours of the evening, consequently this very fact has necessitated the call for the enormous auxiliary turbo-generators with their costly equipment now in construction or in operation in Los Angeles, San Francisco, Oakland, Portland, and other cities of the coast. A careful analysis of these conditions in the article referred to will enlighten the layman greatly as to why a large hydroelectric company can profitably sell power for one cent per kw.-hr. if used continually under full-load conditions and yet the same power company may lose money when selling at six or eight cents per kw.-hr. under spasmodic peak load conditions. In Southern

California there seems to be a strong realization of up-to-date methods in working toward a more even power distribution throughout the hours of the day and night. Exceedingly tempting rates are offered —and offered on a sound business basis, too—for those using power during other hours of the day than at peak load time. In one instance four sets of rates are offered at different hours during each twenty-four hour period, the cheapest being for those who consume power during the so-called "grave-yard shift" or hours from midnight through the early morning watches. The result is that large storage battery equipments are being installed by the railway companies to corral electric energy at these periods and at the same time those using power for pumping purposes find it profitable to inconvenience themselves at off peak hours.

Another interesting deduction brought out is that relating to the ruling of the commission in the way of depreciation, taxes and interest charges for municipal plants. The Journal does not wish to be put on record by either favoring or opposing in general municipal ownership, as we believe that each individual case must be thrashed out on its own merits. It is true, however, that many partisan statements gotten up by over-enthusiasts for municipal ownership materially warp the earnings of municipal plants out of all proportion by neglecting to deduct a proper factor—which in most cases is a very large proportion of the annual earnings—for depreciation, taxes and interest.

The Wisconsin commission has put itself on record in a number of cases showing beyond question that it is only just and proper to annually provide for depreciation whether the plant is owned by the municipality or not. Again, whether or not taxes and interest are actually paid out in case of the municipally owned plant, it is only proper to make this charge in fixing the rates, otherwise the consumer is obtaining an unjust low rate for his power at the expense of the taxpayer.

As years pass by and as there is brought about a clearer understanding of the intricate laws of rate making, those who have thought the public service corporations so grasping in their socalled exorbitant charges must admit that ever widening investigation shows a justice for much higher rates than formerly thought equitable, and they must admit that when the corporations held to their theories with bull-dog tenacity they not only practiced the Darwinian law of self-preservation as being the first law of nature among lower animals, but now that those theories are shown to be just and proper they must admit those high in the council among corporations are in some instances, at least, almost human.

A Reply to Richard T. Crane

Someone has said that a plumber is the only man that enjoys the exquisite pleasure of drawing down one dollar and twenty-five cents an hour for the privilege of sleeping under a bathtub. Be this as it may, the abstract of an article on the futility of technical schools appearing elsewhere in these columns, appears to our western way of thinking so unjust, so uncalled for, we cannot pass it by without a word of protest. The founder and president of Crane Co., the writer of this article, and though perhaps the greatest manufacturer of plumbers' supplies, evidently never slept many hours during the work day or he never could have become the captain of industry that he is today.

Copies of the article referred to have been sent by someone to practically every technical student in our western schools. We regret, we could not print the article in full.

There is much food for thought in Mr. Crane's criticism and yet we feel his vitriolic spleen vented against those engaged in teaching in these higher branches of education is absolutely uncalled for. Undoubtedly there are individuals deserving the criticism, but the great mass of our American engineers devoting their life energies to this work are worthy of the highest praise and consideration for their unselfish and conscientious devotion to their work.

We cannot agree with Mr. Crane's views or results of investigation at all, at least so far as western university men are concerned. In the West constructive features rather than the manufacture and design of machinery engage the attention of the engineer.

Mr. Crane boasts of fifty-seven years in the harness and consequently his qualifications to pass judgment. Some of us have not been fortunate to run our course in life to this extent as yet, nor have we had the exquisite pleasure of attaining the industrial and material success that he has, but yet in our small way we feel qualified to speak from the other point of view—from the point of view of one of those who has gone through the awful socalled blunder of taking a college course and who has gone up against the "hum-bug," "sharp-practice" men known as college professors. Shades of Benjamin Franklin! what visions of protest before our mental view!

Lack of space causes us to pass by a consideration of the unprecedented success of the technical graduates of Stanford, California, Washington, Montana, and our other well-known western institutions. The roll-call of the mines, the power plants, and the legislative halls amply boast their prowess, and even the presidency of the great republic immediately to the south gratefully pay tribute to California. The one thing which seems so utterly forgotten in Mr. Crane's article is the human side of life. The entire criticism seems to smell of a dollar and cent comparison. For our part we believe that in addition to efficiency the question as to whether better, truer, nobler citizens are being put forth should be the final criterion for or against our technical schools. Many of us have gone through the four years of socalled useless studies decried against, have shoulder to shoulder seen the manly struggle, seen the high ideals imbibed and the better, finer grip on life engendered and though we may never become great captains of industry we know we have an inner something, an inner heart-string that has been touched which all the weary grind of the shop, all the painstaking instruction of the foreman as outlined by Mr. Crane could never give us and without which life at best must be but a natural drudge devoid of the higher conception we know it has.

PERSONALS.

C. L. Cory, consulting engineer and rate expert, is at Seatttle on business.

R. W. Van Norden, a consulting engineer of San Francisco, is at Tacoma on business.

Fred Barringer is at San Francisco representing the Barry-Wehmiller Machinery Company of St. Louis.

H. Homberger, consulting hydraulic engineer, has returned to his San Francisco offices from Los Angeles.

Harry T. Hays, purchasing agent for the Mount Whitney Power Company, was at San Francisco from Visalia during the past week.

Edward G. Dewald, hydraulic engineer, joined the sales staff of Pierson, Roeding & Co., on December 1, with headquarters at San Francisco.

E. P. Waller, assistant to H. E. Barry, manager of the General Electric Company's railway department, is visiting the company's San Francisco office.

R. L. Phelps, Pacific Coast manager for the Safety Insulated Wire and Cable Company, has returned to San Francisco from a trip throughout the Northwest.

C. H. Holley, of Lindsay, who is secretary of the Tulare County Power Company, has been at San Francisco for several days closing up electric power contracts.

F. W. Wachter, who has independent long-distance telephone interests in Southern California, is at San Francisco conferring with officers of the Home Telephone Company.

Sidney Sprout has returned to San Francisco after a trip to Siskiyou County in connection with the extensions of the Siskiyou Electric Light and Power Company's hydroelectric system.

John T. Giblin of the McGuire-Cummings Manufacturing Co., Chicago, was a recent San Francisco visitor, representing his company in their bids for the Geary-Street railway equipment.

Charles Manley, former manager of the Crescent City Light and Water Company, who now has an electric lighting plant of his own, has been spending a few days at San Francisco.

W. R. Dunbar, of the detail and supply department of the Westinghouse Electric & Manufacturing Company, has returned to the San Francisco office after spending six weeks at East Pittsburg.

William C. Getz, Signal Service at Large, U. S. A., has left Chicago, Ill., for Manila, P. I., where he will take charge of the construction of wireless telegraph stations and apparatus in the Philippine Divisions.

S. G. McMeen, formerly general manager of the Bay Cities Home Telephone Company of San Francisco, has been elected president of the Mt. Hood Railway & Power Company and has established his headquarters at Portland, Ore.

Geo. J. Henry Jr. and Wm. Ward of the Pelton Water Wheel Company were at Los Angeles during the past week in connection with the opening of the bids on the waterwheels for the power plant of the Los Angeles aqueduct.

Glenn C. Webster, manager of the engineering department of the National Electric Lamp Association, made an exceedingly interesting and instructive talk at the preliminary electrical league meeting in San Francisco on November 28th.

Henry T. Scott, president of the Pacific Telephone and Telegraph Company, gave a large luncheon at the Hotel St. Francis last Tuesday, with Theodore N. Vail, president of the American Bell Telephone and Telegraph Company as the guest of of honor.

W. C. Wagner, electrical and mechanical engineer of the Northwestern Improvement Company, has accepted a chair in the department of electrical engineering of the University of Washington, for the coming year, substituting for Dr. C. E. Magnusson, who is absent on leave.

Stanley Walton, manager commercial department of the Pacific Gas and Electric Company, left on the 1st of December for Chicago, where he will attend the National Irrigation Congress. Mr. Walton is collecting much valuable data on power consumption and costs for power used in pumping for irrigation.

M. D. Spencer, who has been the manager of the Oregon Power Company at Eugene, Oregon, for the past two years, took charge of H. M. Byllesby & Co.'s electric plants at Everett, Snohomish and Monroe, Washington, on December 1. His successor at Eugene is R. M. Jennings, who is leaving the management of the Byllesby plants at Marshfield and Coos Bay.

C. F. Elwell, chief engineer of the Federal Telegraph Company, has returned to San Francisco from an extensive trip in the Northwest, where he made arrangements to establish several Poulsen wireless stations. The Medford and Portland stations are now completed and in commercial operation, giving wireless communication as far east as Fort Worth, Texas.

OBITUARY.

George W. Hebard, acting vice-president of the Westinghouse Electric & Manufacturing Company, died at his home in New York City, on Friday, November 17th. Mr. Hebard

George W. Hebard

was born in Barre Center, Olean County, New York, in 1845, and was, therefore, 65 years of age. He had been in poor health for some time previous to his death.

The death of Mr. Hebard is the third one to occur in the last few months among the higher officials of the Westinghouse Electric & Manufacturing Company, residing in New York; the others being Mr. Edward St. John, treasurer, and Mr. Robert Mather, chairman of the hoard of directors, the latter's death a few weeks ago having been a great shock to his wide circle of acquaintances.

ELECTRICAL MEN PLAN A CLEARING HOUSE.

The most widely representative meeting of electrical men ever held on the Pacific Coast convened at luncheon at Tait's Cafe in San Francisco on November 28. Mr. S. J. Lisberger presided as chairman and after briefly summarizing the recent efforts to bring about a mutual spirit of co-operation among the many electrical interests there represented, introduced the several speakers with a few appropriate remarks.

Albert H. Elliott, the first speaker, stirringly outlined the advantages of co-operation and in a most eloquent manner paved the way for much of the meeting's subsequent action. He traced the development of the get-together spirit through past ages and urged that the electrical men of the Pacific Coast do likewise in the broad spirit of helping the public to a better understanding of the uses of electricity.

W. S. Hanbridge, secretary of the Electrical Contractors' Association, spoke of the need for co-operation between the manufacturer, jobber, central station and contractor, and pledged the active support of the electrical contractors in furthering this plan.

Glenn C. Webster, manager of the engineering department of the National Electric Lamp Association, gave the gathering an account of the work of similar electrical leagues in the East. He stated that one of the fundamental laws for success is in giving the greatest good to the greatest number. In the electrical business this must include the consumer, perhaps the most essential element in the electrical body, and as such entitled to every consideration. Recognition of this fact is embodied in the substitution of McAdoo's phrase, "the public be pleased," for the unfortunate expression accredited to Vanderbilt.

In conclusion Mr. Webster said:

"It is very true that men who don't get together don't know each other. I believe it is a recognized fact that men who have striven alone if they have been able to rise to a position it was because there must have been a great amount of good in these men. If you will get together, if you will know each other and will honestly try to work out the problems that will come before you, you will say that unity is alright.

"It seems to me as we sit here every man is a brother in the electrical fraternity and can go out and create public sentiment on the line of fundamental truth. Even this number of members could almost mould sentiment for electricity. How are you going to get at this? Any movement that amounts to anything takes a lot of work. It takes "man hours." If the Electrical League, if you would call it that, is going to work it is going to take "man hours" to do it. You are going to get pay for those hours. When a man gets so busy that he can't attend to business he is going to drop out of the race. In order to get the fellows to work I say get them something to do. Committees should be appointed such as a public policy committee, street lighting committee, power committee, publicity committee, with the idea of having something for the fellows to do, so they would feel they were a part of the body. You bring out men you don't know in this way. It also lessens the work of the officers. With this viewpoint in mind I believe the field here is large."

Geo. C. Holberton, manager of the San Francisco Gas and Electric Company, assured the enthusiastic endorsement of this project by his company and incidentally spoke of the easy manner in which several minor obstacles might be removed.

T. E. Bibbins, manager of the General Electric Company's San Francisco office, likewise approved the proposal and pledged the support of the General Electric Company.

W. W. Briggs of the Westinghouse Electric and Manufacturing Company, in his usual happy manner, advocated that the electrical men cease their small bickerings and "get together, all the time, for everything electrical."

Chairman Lisberger then stated that the proposition depended upon the wishes of those present. Action was immediate and enthusiastic. In quick succession it was decided to form an electrical league and for that purpose the original committee, consisting of S. J. Lisberger, H. V. Carter and E. B. Strong, were empowered to select seven others to act as a general committee to report at a meeting on December 12. At that time a constitution and by-laws will be presented and suggestions made for officers and committees. Due notice of this meeting will appear in these columns next week and every electrical man of San Francisco is earnestly invited to attend.

The following were in attendance at this preliminary meeting:

Glenn C. Webster	Fred L. Webster	A. E. Drendell
R. M. Alvord	H. V. Carter	Garnett Young
John R. Cole	A. E. B. Ridley	W. H. Seaver
Geo. A. Sittman	Louis Levy, Jr.	H. C. Reid
H A. Lardner	C. E. Reller	Samuel Hamilton
Wm. L. Goodwin	Edward Whaley	W. W. Hanscom
F. A. Leach, Jr.	P. C. Butte	J. N. Bachman
W. D. Kohlway	H. B. Squires	G. J. Peters
Sam Heyman	C. E. Wiggins	F. B. Gleason
H. A. Russell	L H. Newbert	W. S. Berry
H E. Sanderson	R. F. Oakes	T. E. Bibbins
H. T. Adams	S V. Walton	S. J. Lisberger
N M. Hope	G. I. Kinney	R. W. Van der Naillen
W S. Hanbridge	C. W. Gortini	A. R. Saurman
M. D. Kirsten	Frank E. Smith	W. W. Briggs
H. C. Goldrick	F. E. Cronise	Van E. Britton
H. R. Noack	L. R. Boynton	G. B. Ocheltree
W. F. Neiman	H. W. Crozier	P. Decker
Albert H. Elliott	R. L. Waldron	R. D. Holabird
M E. Quinn	M. A. Bryte	A. H. Halloran
J. S. Baker	F. W. Watts	Robert Sibley
Jas W. Redpath	C. D. Pierce	E. B. Strong

ELECTRICAL CONTRACTORS' NOTES.

L. R. Boynton of the Central Electric Company, took a flying trip to Los Angeles last Monday night.

Noble Powell, an electrical contractor of Stockton, spent last Tuesday at San Francisco.

Paul Butte of the Butte Engineering and Electrical Company, spent the past week at Portland.

A number of the San Francisco electrical contractors left last Friday night for Los Angeles to attend the Electrical Show which is still in progress.

The management of the new St. Luke's Hospital at Valencia and Duncan streets, are installing their own electric power plant. All of the bids are in for the electrical work on the building and the contract will probably amount to about $20,000. Louis Hobart is the engineer.

The McFell Electric Company is nearing the completion of a $17,000 electric wiring contract at Fort Miley.

The merchants of Stockton are about to install three hundred ornamental electric lamp posts on the principal thoroughfares of that city. Two electric power companies are competing for the contract of furnishing the current for the lights.

TRADE NOTES.

The government of Formosa has awarded a contract to the Allis-Chalmers Company for a completely equipped sawmill, which is to be electrically driven. Allis-Chalmers steam turbines will supply current for power and lighting throughout the large mill plant.

The Fort Wayne Electric Works has secured the contract for several carloads of induction motors and switchboard equipment, for a pumping installation for the Patterson ranch near Modesto. There will be seven or eight pumping stations. The pumps, of several different types, will be supplied by the California Hydraulic and Engineering Company.

LOS ANGELES ELECTRICAL EXPOSITION.

The Los Angeles Electrical Exposition made an auspicious and brilliant beginning on Saturday evening, November 25 and will continue to impress the wonders of electricity upon the people of the southern metropolis for the next fortnight. The Shriner's Auditorium is peculiarly well adapted to accommodate an exhibition of this character and its architectural features have been admirably utilized in emphasizing the advantages of this ideal source of light and power.

The general illumination as furnished by sixty magnetite arcs suspended from the lofty roof trusses, was supplemented by spans of thousands of green incandescent lamps entwined in evergreen. Handsome pedestals of white and gold surmounted by electric globes defined the spacious aisles and booth boundaries which allowed generous space for promenade and inspection.

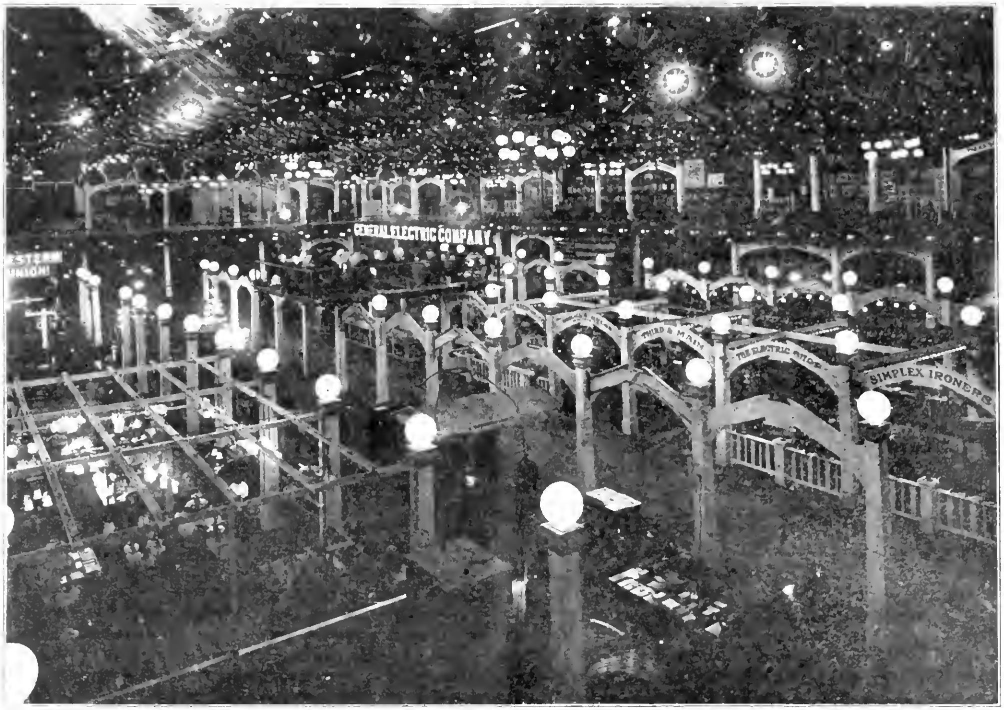


Photo by W. C. Lloyd — The Los Angeles Electrical Exposition

Most of the exhibits were calculated to appeal to the popular mind as will be noted in detail hereafter. Preliminary gate receipts indicate that this ambitious project will be as successful from the financial side as it is from the general excellence of the display.

National Electric Lamp Association had a beautiful exhibit at the right of the entrance to the main floor comprising a full line of Mazda lamps of all possible sizes, from the great 400-watt globes to the beautiful miniature and decorative lamps, and for all possible purposes, from the exacting requirements of automobile and train lighting to those of house illumination. These lamps were attractively displayed in various cases and racks. Many of them were equipped with the several makes of illuminating glassware, such as the Holophane, Fostoria, Alba, Luceo and Mello glass, showing the manner in which they can best be utilized. Samples were shown of tantalum and Gem lamps. This exhibit was under the personal charge of Glenn C. Webster, general manager of the engineering department of the National Electric Lamp Association and F. J. Blaschke.

The General Electric Company occupied a similar space at the left of the main entrance, filled with the many varied devices which they manufacture. These included a full line of alternating and direct current small motors for the thousand and one industrial and household purposes, buffers, polishers, razor sharpeners, sewing machines, vacuum cleaners, etc. A stock motor running continuously under water attracted considerable attention. In addition to this a number of large motors, including a R-I type with variable speed connection, automatic starters and frequency regulators were shown. Special attention was devoted to a complete line of wiring devices, sockets, and switches for the contractors' use. Various electrical measuring instruments, as well as the indicating and recording flow meter, were demonstrated. A miniature stage equipped with strip lights, flow lamp, dimmer and other accessories was used to display a number of lantern pictures. A mercury arc rectifier and stage dimmer was employed in this mechanism and an elaborate electric ballet exhibited. The usual line of fans, lamps and radiators were shown as well as an electric ozonator. The utility of General Electric cooking devices were practically demonstrated and the viands served from an electrically equipped dining room.

Woodhill-Hulse Co. occupied the adjoining booth on the main aisle with a beautiful display of lights, heating devices and the myriad household appliances such as, washing machines, vacuum cleaners, and electric irons now available. The same firm also occupied a large booth on the side in which was exhibited switchboards and general wiring supplies, as well as the special exhibits from the Standard Oil Company, consisting of a model oil pumping rig and an automobile racing device to advertise lubricating oil.

Southern California Edison Co. utilized the remaining of

the very large spaces on the ground floor. In addition to a portable substation which supplied power for all the exhibits in conjunction with a transformer equipment of the Los Angeles Gas & Electric Company, particular interest attached to this companys graphic exhibit and explanation of meter reading. Several attendants were continually in charge to explain to all consumers how meters are read and bills calculated. In connection with the magnetite arc illumination of the building the company exhibited its mercury arc rectifiers and continuous current transformer equipment which took care of the two circuits of 30 arc lights each. Direct current was also furnished to a number of exhibitors by means of a 60 h.p. motor generator set, operated in their booth.

The Pacific Electric Railway Company exhibited a model of their car and fender equipment and inside the car operated a moving picture machine showing various scenes along their lines in the vicinity of Los Angeles. They also exemplified the working of their new block signal system and the Hart automatic flag-man, furthermore exhibiting a model of their standard rolling stock and line construction.

W. B. Palmer, representing the Cutler-Hammer Manufacturing Co. and the Crocker-Wheeler Co., had a most spectacular exhibit on the main stage and gave hourly demonstration of the wonders of high frequency electric current, including electric welding and an electric chair. The Cutler-Hammer Company exhibited a full line of their heating appliances, push button specialties, magnets and starting devices. The Crocker-Wheeler exhibit included a large number of small motors and transformers.

The remaining booths on the main floor were filled as follows:

Standard Underground Cable Company exhibited a typical line of lead covered cables of all sizes, from those for burglar alarms to heavy power conductors, Davis open air terminals and Nordyke cable supports, as well as a large variety of insulated wires and cables.

Bell & Jamieson operated a large electric track bonding machine manufactured by the Electric Railway Improvement Company of Cleveland.

Wm. N. Glockner displayed a number of Wurlitzer mechanical pianos, including a mandolin sextette, harp, violin piano and orchestrian.

Western Union Telegraph Company showed a full line of telegraph instruments and demonstrated machine sending and receiving of typewritten letters.

B. F. Kierulff & Co. carried a representative display of samples of the products of their Eastern principals, including G. I. Mazda lamps, Fort Wayne transformers, motors, fans and meters, Mathias Klein & Co.'s wiremen's tools; Sprague motors and generators, Pittsburg high voltage insulators, Cutter street lighting posts, Eichhoff wire reels, Lord trolley retrievers, St. Louis Malleable Casting Company's overhead line material, W. A. Clark weatherproof and bare and covered wires and cables and the products of the Pacific Wire Rope Company.

Baker-Chase Electric Company in addition to exhibiting a full line of the Pacific Electric Heating Company's various specialties, had a most beautiful and attractive display of lighting fixtures and lamps of all kinds.

Haskins Glass Company occupied the adjoining booth with a large display of illuminating glassware.

The Home Telephone Company maintained and operated a branch exchange and telephone booth for the convenience of the show's patrons.

The Standard Electric Time Company demonstrated the operation of their master and secondary clock system.

Duntley pneumatic cleaners were demonstrated in the adjoining booth. The Globe Flour Mills operated a motor driven mill, showing the process of the manufacture of flour.

Various electric vehicles, including the Columbus, Detroit, Ohio, Bailey and Lamsden, filled the elevated platform surrounding the main floor as well as an exhibit of the electric stereoptigraph and the Los Angeles Brass Manufacturing Company.

The Kelman Electric & Manufacturing Company occupied a large space in the main hall entrance with an interesting exhibit comprising a 10,000 volt oil circuit breaker, a 30,000 volt three-pole double break oil circuit breaker, as well as a 60,000 volt ceiling type disconnecting switch and a 30,000 volt wall type disconnecting switch.

The Luitwieler Pumping Engine Company occupied an adjoining booth with several pumps varying in size from 1 to 30 h.p.. A 2½ h.p. pump was run upon a support consisting of but four water glass tumblers on a saw horse to show the lack of vibration.

Electric milking of cows proved a centre of popular attraction.

The Electrical World and the Journal of Electricity, Power and Gas displayed their publications.

The United States Government installed a most extensive series of exhibits, comprising models of early types of electric machinery from the Smithsonian Institute, and models of several warships and transports as well as a full display of guns, electric navy equipment and wireless apparatus employed by the Navy Department. On the upper floor, also, the Bureau of Standards gave a most interesting exemplification of the standardizing work being done in Washington and of their various publications. This exhibit included a large number of instruments of precision of all kinds, the primary electric standards and tubes of rare gases. The United States Weather Bureau displayed a line of weather maps and forecasting instruments.

Other exhibits on the upper floor included the following:

United States Electric Manufacturing Company displayed a line of small motors, generators, transformers and switches with an attention-compelling high frequency apparatus

J. C. Farrar & Co. had an attractive exhibit comprising E. E. E. pipe frame fittings, cable end bells for outside and inside service, bus bar supports, air boxes and transformers, water bells, a full line of Swartout steam specialties, including separators, exhaust heads and building ventilators. They also demonstrated the Electro-Magnetic Tool Companys electric hammer and showed a line of lightning arresters manufactured by the Lord Manufacturing Co.

John A. Roebling Sons Co. showed bare and insulated covered wire and cables and wire rope.

The Southern California Electric Company displayed an interesting model of the Mt. Lowe electric railway and demonstrated various electric toys, heating devices, washing machines, vacuum cleaners, etc., as well as giving a full display of Monarch lamps.

Gans Bros. exhibited an interesting line of electric novelties, toys, wireless apparatus and household appliances.

Kellogg Switchboard & Supply Company made a large exhibit of telephone instruments and parts for various services and also showed the Delco automobile ignition device and Columbia batteries.

The Empire Electric Company as the successors of the Electro-Mechanical Laboratories Company, showed a general line of E. J. Rose's high frequency apparatus for physician's use and contributed to the show's popular interest by demonstrating X-Ray apparatus and high frequency freaks.

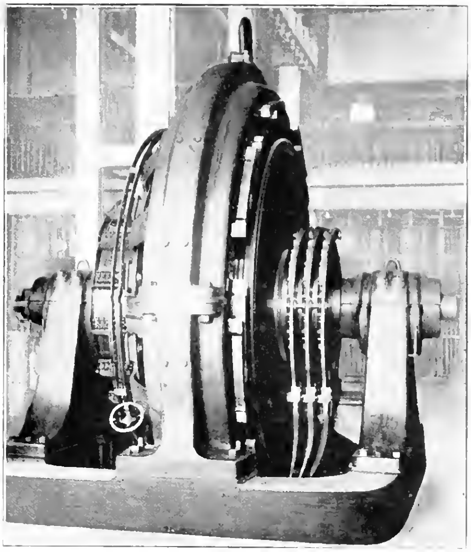
The Tuttle-Stevens Manufacturing Company showed electric ovens. The Los Angeles Silk Works operated a silk loom and made an exhibit of silks. Other exhibits comprised Tuec standard cleaners, Hobart coffee mills, the Multigraph, Dictaphone, the Los Angeles Evening Herald and electric automatic incubator.

INDUSTRIAL

3000 KILOWATT ROTARY CONVERTERS.

For the economical transmission of energy as direct current either close proximity of the generator to the point of power application, or the use of alternating current for transmission is necessary. For this reason direct current for railway service is seldom generated as such in this progressive age. The tendency is to generate all energy as alternating current in large economically located stations, and to transmit it as alternating current to sub-stations located in the section where it is utilized as direct current in the railway motors. Rotary converters because of their exceedingly high efficiency are peculiarly adapted and are usually used in the sub-stations for converting from alternating to direct current.

It is recognized that the combined efficiency of a rotary converter and its transformers is considerably higher than that of a motor generator set of equivalent capacity and voltage. This advantage in efficiency is even more marked at light loads than at full load, and since the load factor of railway systems is usually low, the inherent fitness of the rotary converter is evident.



3000 kw., 25 Cycle, 6-Phase, 600 Volt Rotary Converter for Interborough Rapid Transit Co.

The growth of traction systems has been so rapid of late in the larger cities that it has been necessary to materially increase the outputs of the sub-stations. It was desirable, and practically necesary in some cases, to do this without increasing the sizes of the sub-stations without increasing real estate investment. The Westinghouse 3000 kw. rotary converter offers the solution to this problem in that with it maximum output can be obtained with minimum floor space.

The Westinghouse 3000 kw., 600 volt, 187½ r.p.m. (25 cycle) rotary converter, the largest in output ever constructed, is being received most favorably by operating companies because of its strength, compactness, economical operation, and the minimum amount of floor space required. Rotary converters of other makes of greater bulk but of smaller output have been manufactured.

While some of these 3000 kw. rotary converters are started from the direct current end, all are designed for alternating current self starting and several will be regularly started by this method.

NEW CATALOGUES.

"Guess Which of Them Is Copper Clad?" is the title of a leaflet just issued by the Duplex Metals Company, of Chester, Pennsylvania.

The Wirt Electric Specialty Company of Germantown, Penn., has just issued Bulletin No. 1106 on di-el-ite resistance units used in the resistors covered in the patents of Charles Wirt.

The Helios Manufacturing Company of Philadelphia, are distributing through their San Francisco agency, G. A. Wilbur of 78 Second Street, their new illustrated Bulletin No. 72, which covers alternating current flame arc lamps of various voltages.

Bulletin No. 1525 of the Allis-Chalmers Company describes type AA7 compressor for air brake equipments. This machine is of new design throughout and embodies many features which show a distinctive advance over previous motor-driven compressor designs.

The current number of The J-M Roofing Salesman, one of the two house organs of the Cleveland Branch of the H. W. Johns-Manville Co., is largely devoted to pictures showing the many different classes of buildings covered with "The Everlasting Roofing."

The Allis-Chalmers Company has just issued Bulletin No. 1075 on belted alternating current generators. The pamphlet thoroughly illustrates the designs manufactured by the company. Bulletin No. 1525 deals with type AA-7 compressors for air brake equipments.

The engineering department of the National Electric lamp Association has issued Bulletins No. 16 and 17. The former deals in an instructive manner with "Mazda" incandescent street lighting while the latter recounts the economical operation of incandescent lamps.

The H. Mueller Manufacturing Co. of New York City has just issued the second exhaustive edition of their Catalogue D. The catalogue is cloth bound and thoroughly illustrates the standard specialties carried by the company among the more important of which are tapping machines, corporation cocks, water connections, lead flange work, pressure regulators and tools.

The General Electric Company has just issued Bulletin No. 4899, illustrating and describing its Expulsion Fuses and Fuse holders. These are for use on circuits having voltages up to and including 110,000. The company has also just placed on the market a new piece of apparatus known as a Battery Truck Crane, which the company describes in its Bulletin No. 4892, recently issued. The bulletin contains illustrations of the truck and crane in use, and describes also various pieces of apparatus used in connection with it.

Descriptive Leaflet 2373, issued by the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa., describes the No. 303-A box frame interpole motor manufactured by that company. Complete specifications for the motor, brief descriptions of the important parts, and performance curves are given on the sheet. Descriptive Leaflet 2374, also recently issued by this company, gives specifications and brief descriptions of the parts of the company's box frame interpole railway motor No. 310-C. This leaflet is similar in general make-up to the one above described.

NEWS NOTES

INCORPORATIONS.

PORTLAND, ORE.—Power Plant Equipment Company of Portland, Ore. Capital. $10,000.

SANTA FE, N. M.—The Silver City Power Company has been incorporated with a capital stock of $100,000. The incorporators are: L. B. Downey, E. T. Hann, J. W. Carter.

SAN FRANCISCO, CAL.—Merced River Electric Power Company, San Francisco, $10,000,000, by L. M. Gove, H. L. Breed, C. Gross, J. E. Bowes and M. S. Hamilton.

HOOD RIVER, ORE.—The Hood River Gas & Electric Company, capital $100,000, has been incorporated by J. Flynn, Fred A. Martin and W. M. Daly. It is rumored that the new company is a subsidiary corporation of the Pacific Power & Light Company.

CASTLE ROCK. WASH.—The Castle Rock Light & Power Company, capital $250,000, has been incorporated by A. E. Braden, H. B. Davis and I. W. Belden as stockholders. The company's central offices will be established at Tacoma and will expend the sum of $10,000 on an electric light plant to furnish this town with lights.

EL CENTRO, CAL.—The Imperial Southside Water Company has been incorporated with a capital stock of $200,000. The principal place of business is Holtville and the incorporators are: C. D. Hartshorn, G. L. Melton, F. S. Best, Clark Rcoher and S. B. Otter. Water will be developed and a canal built in the southeast portion of the valley for carrying an ample supply of water.

SAN FRANCISCO, CAL.—The Feather River Power & Irrigation Company, with a capital stock of $10,000,000 authorized, and purpose set forth to do business in all parts of California, November 21 filed articles of incorporation with the county clerk. R. K. Burrows of Larkspur, A. N. Lewis Jr. of Alameda, A. L. Dahl of San Francisco, H G. Hill of San Francisco and F. C. van Deinse of Berkeley, are named as incorporators.

SACRAMENTO, CAL.—Articles of incorporation of the California Telephone and Light Company have been filed with the Secretary of State. The company is a Santa Rosa concern, capitalized at $10,000,000, and operates seven miles of telephone lines. The directorate is comprised of John E Bennett of Palo Alto, F. L. Wright of Santa Rosa, A. H. Spurr and M. S. Sayre of Lakeport, S. Pickering of Santa Rosa and H. L. Ney of Kellogg.

ILLUMINATION.

EUGENE, ORE.—The $25,000 electric light bonds recently floated have been purchased by local people. Clusters will shortly be installed on the streets.

CENTRALIA, WASH.—The Washington-Oregon Corporation has made application for a franchise to erect poles for electric light wires along the county road between Littell and Adna.

WALLA WALLA, WASH.—The Attalia Land Company has filed with the County Commissioners a petition asking for a franchise to construct electric light and telephone lines in Walla Walla, for fifty years.

OAKLAND, CAL.—Mayor Frank K. Mott has received a communication from F. A. Leach Jr., manager of the Oakland Gas, Light & Heat Co., stating that beginning with December 1 of this year the rate for electricity for lighting by meter measurement will be maximum 7c per 1000-watt hours, with a sliding scale to 3c per 1000-watt hours. The present rate is 9c graduated to 3½c.

LEWISTON, IDAHO.—This city has adopted the tungsten plan of lighting in preference to others, and has instructed the lighting company to install same.

KALISPELL, MONT.—The Northern Idaho & Montana Power Company has received a contract for the lighting contract here.

PASCO, WASH.—The proposition of purchasing the water works system and plant of the Pacific Power & Light Company was defeated at a recent bond election.

AMITY, ORE.—Amity citizens desire the installation of a city water system, and the City Council has the matter under advisement.

SANTA ROSA, CAL.—The Supervisors have passed an ordinance granting to the Pacific Gas & Electric Company a franchise for laying and maintaining gas pipes, mains and conduits in the County of Sonoma.

CHICO, CAL.—An ordinance has been passed by the Supervisors granting to the Pacific Gas & Electric Company the right to lay gas pipes, mains and condnits in the County of Butte, in the vicinity of Butte.

GLENDALE, CAL.—City Trustees have accepted the offer of L. C. Brand to transfer the Glendale Light & Power Company's West Glendale system to the city for $55,000. The system will be enlarged and improved.

MARSHFIELD, ORE.—Plans are being made for the development of a large water power plant on the South Fork of the Coquille River in this county. M. J. Anderson of Grants Pass, with his associates, owns the water rights.

MERCED, CAL.—The San Joaquin Light and Power Company is extending its work of laying new gas mains. The company intends to lay new and larger mains to all parts of the city. At the present time a force of 60 or 70 men is employed.

FALLON, NEV.—The bond issue for the purpose of raising money to construct an adequate sewer and water system has been disposed of and the money is in a local bank. Bids for the construction of the system will be advertised for within a few days.

DIXON, CAL.—The Pacific Gas & Electric Company has the material on the ground for a new substation which is to be considerably larger and much more modern than the one now in use. The structure is to have a concrete floor, iron beams and girders, the walls and roof to be of corrngated iron and the machinery to be installed in it of the latest and best pattern.

BERKELEY, CAL.—Frank A. Leach Jr. of the Oakland Gas, Light & Heat Company has notified Mayor J. Stitt Wilson that his company had voluntary reduced its rates in Berkeley. A recent ordinance put the electric rate at 8½c which the company now cuts to 7c. The gas rates have been 90c per 1000 cubic feet for fuel and $1 for illuminating purposes. The new schedule puts the rates at 90c per 1000 cubic feet a month.

TRANSPORTATION.

BLAINE, WASH. The City Council has granted a franchise to the Nooksack Valley Traction Company for railway construction over local streets.

HUSUM, WASH.—Trustees of the Northwest Electric Company held a meeting in Portland recently to decide the question of starting operations.

LOS ANGELES, CAL.—The Board of Supervisors will receive sealed bids up to December 26th for the right to construct and for a period of 40 years to operate an electric railroad along certain public highways of Pasadena.

SAN DIEGO, CAL.—The council has voted to issue a 41-year street railway franchise to the San Diego Electric Company on F street, from Fourth to Third street, for a bid of $150. The new line will connect with Spreckels' lines.

LOS ANGELES, CAL.—E. D. Goode of Glendale, C. P. Grogan, T. Miller and residents of San Fernando are projecting an electric railway line for San Fernando, to be built under the direction of the Mission Land Company.

BAKERSFIELD, CAL.—The trustees have passed an ordinance granting the San Joaquin Light & Power Corporation a 49-year franchise to build and operate a street railway on Chester avenue, from Twenty-fifth to Thirty-fourth street. The company was the only bidder, its bid being $250.

SAN FRANCISCO, CAL.—The Board of Public Works has deferred for a week taking action on the four bids for furnishing 43 cars needed for the Geary street municipal railway. The delay was ordered at the request of the Home Industry League, the Civic League of Improvement Clubs and other organizations.

PRINEVILLE, ORE.—Mrs. L. B. Kerwood, supposed to represent an eastern syndicate of capitalists, recently stated before the Commercial Club of this place that the year 1912 would bring about the completion of an electric railroad connecting this place with the Deschutes & Oregon Trunk Railway at Metolius, to follow closely the bed of the Crooked River.

PRINEVILLE, ORE.—Louis Gerlinger Jr., general manager of the Salem Falls City & Western Railroad, and W. J. Taylor, of Portland, Ore., visited Prineville this week and went over the proposed routes for the new electric railway from Metolius to Redmond, along the line of the Deschutes and Oregon Trunk Railway. No definite statement was made, but it is known that the proposition is considered with favor, owing to the fact that there is an abundance of power in the Crooked and Deschutes Rivers for operating an electric railroad cheaply.

TRANSMISSION.

WENATCHEE, WASH.—The Wenatchee Valley Gas & Electric Company has purchased the plant of the Valley Power Company at Dryden, the deal involving something over $250,000.

DORRIS, CAL.—The bid of the Siskiyou Electric Light & Power Company for a franchise for stringing and maintaining wires in the corporate limits of the town of Dorris has been accepted.

CASTLE ROCK, WASH.—The City Council has passed an ordinance granting to H. B. Davies, J. W. Selden and the Tacoma Investment Company the right to construct and operate electric light lines within the city.

WALLA WALLA, WASH.—A 50-year franchise has been granted the Pacific Power & Light Company for setting poles and stringing wires over the streets and alleys at Attalia, where the Grinnell Company, recent purchasers of the Attalia irrigation project is now planning the installation of an electric pumping plant.

SAN BERNARDINO, CAL.—The central stations' first distributing line contract for the Southern Sierras Power Company of this city has been awarded by the Sierras Construction Company to M. H. French. The work must begin immediately and be completed before February 10, 1912. The contract price is $159 per mile.

VISALIA, CAL.—The Board of Supervisors has passed an ordinance granting the Pacific Light & Power Corporation a franchise to construct and for a period of 30 years operate an electric tower and pole and wire system upon certain public highways in the county of Tulare.

WENDELL, IDAHO.—Lafayette Hanchett of Salt Lake City, a member of the board of directors of the National Copper Bank at that place, while visiting this city, stated that work will start shortly on the Thousand Springs power plant. The enterprise is backed by controlling interests in the National Copper Bank and warrants its completion. The Westinghouse Machinery Company will furnish the power plant machinery. The plant will cost $500,000 and will generate 5000 h.p. at a cost of $500,000.

TELEPHONE AND TELEGRAPH

MARIPOSA, CAL.—The Supervisors have granted the petition of James D. Westfall and others for the erection of a private telephone line on and across the public roads of Road District No. 5.

BELLINGHAM, WASH.—The Farmers' Mutual Telephone Company is to start work on the building of a new trunk telephone line from Bellingham to Sumas, according to announcement made by General Manager Don D. Clark.

RED BLUFF, CAL.—The Tehama County Telephone Company has commenced the construction of its long-distance line, running south from Red Bluff, stringing its wires on the Postal Telegraph Company's poles. Heretofore this company has confined its operations to local service in Red Bluff and Corning and in outlying districts.

WATERWORKS.

ELLENSBURG, WASH.—Bids will be received by J. A. Crimp, city clerk, of this city, up to November 20th, for electric light and power bonds in the aggregate sum of $110,000.

BURLINGAME, CAL.—Burlingame proposes to install a municipal water system and following the recommendation of the water commission, the trustees appropriated $1000 to prepare plans. The water commission consists of Eric Langel, Victor H. Woods, E. F. Verrill, Dr. H. d'Arcy, A. M. Power and C. J. McGregor.

TUCSON, ARIZ.—The City Council and Board of Trade are busy planning for a water supply for the city. The city has plenty of machinery, but it is not properly placed, and the main supply pipes are not large enough. It is possible that a large storage and pressure reservoir may be built in the near future, especially for fire protection.

PASCO, WASH.—A contract has been awarded by the council to Evans-Dickson Company, electrical engineers, of Tacoma, for furnishing 84 ornamental street lights at $7000. The casting required will be furnished by the Olympic Foundry Company, Argo Station, Seattle, which holds patent rights on the design of post selected by the City Council.

REDDING, CAL.—W. A. Cooper, secretary of the Mount Shasta Power Company, has filed a waiver on the part of the Central Pacific Railroad Company, in consideration of $12,000 for all damages that may accrue to its property because of the diversion of water from Pit River in the Big Bend. The waiver also includes the right of way for pole lines. The point of diversion for the Mt. Shasta Power Company is three miles up the Pit from the point of diversion for the Northern California Power Company's 120,000 h.p. project. The Mt. Shasta Power Company has been doing considerable work on the quiet. Work on the tunnel that is to be 150 feet less than seven miles in length was commenced last fall and over a quarter of a mile of the tunnel has been dug. The fall at the outlet of the tunnel and canal will be 900 feet.

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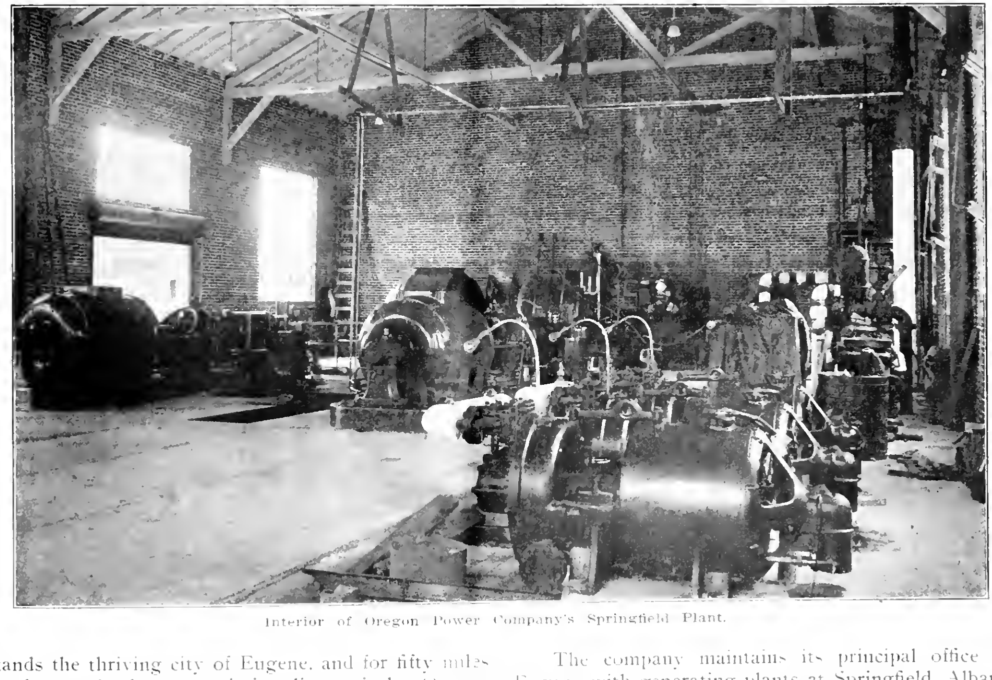
THE OREGON POWER COMPANY

BY A. H. HALLORAN

Oregon's most famous valley is that of the Willamette, whose thirty-mile width parallels the lofty crest of the Cascades for nearly one hundred and fifty miles to its junction with the mighty Columbia. At the head of this great valley, checkered with fields and orchards and flanked by mighty forests of fir, stands the thriving city of Eugene, and for fifty miles to the north the transmission lines of the Oregon Power Company distribute light and power to a busy and prosperous people.

Nature has endowed this country with fertile soil, a beneficent climate, abundant waterpower, great mineral wealth and tremendous timber resources. Man has created an environment of culture and refinement by the establishment of two State colleges, at Eugene and at Corvallis, which are attracting a most desirable class of homeseekers.

The several electric power, gas and water plants which supply the needs of this community were acquired by the Oregon Power Company, May 1, 1910, and the various improvements and extensions which have been completed since that time make their description a matter of present interest.



Interior of Oregon Power Company's Springfield Plant.

The company maintains its principal office at Eugene with generating plants at Springfield, Albany and Dallas. These and intermediate towns are tied together by an extensive network of high voltage transmission lines.

Springfield Steam Plant.

The company's largest plant is at Springfield, 3½ miles east of Eugene on the east bank of the Willamette, the two towns being connected by electric railway. This plant has a capacity of 3000 kw. in

Exterior of Springfield Plant After Fire.

three steam turbine units, generating three-phase power at 60 cycles, 2300 volts.

These units comprise a 2500 k.v.a. horizontal Curtis turbine generator, operated at 1800 r.p.m., and two 500 kw. horizontal Allis Chalmers machines, operated at 3600 r.p.m. Excitation current is furnished by three 35 kw., 125 volt dynamos driven by horizontal Curtis turbines.

The control of this apparatus is exercised through a 13 panel switchboard on the main generator floor. These panels comprise four generator sections (one blank for future 2000 kw. unit) three exciter sections, one Tirrill regulator, four feeder panels and one small arc light panel for the street lights of Springfield. All the connections between the machines and the switchboard are made with asbestos covered cables run in tile ducts.

Steam is furnished at 150 to 160 lb. pressure by two 500 h.p. Stirling boilers and three Cahall water tube boilers, one of 400 and two of 300 h.p. The plant is of peculiar interest on account of the fact that sawdust is used as fuel, each boiler being equipped with Dutch ovens for this purpose. These ovens feed from above through a chain conveyor from the mill

This plant was built within 100 ft. of the Booth-Kelly Lumber Company's mill which was burned to the ground in July of this year and which was the source of sawdust and slab wood for fuel. That the power plant was not burned confirms the wisdom of the company's engineers in advocating a fire-proof station in spite of its greater cost as compared with a wooden building and corrugated iron covering.

The building is a brick structure on concrete foundations with a concrete pit containing the auxiliary apparatus below the generator floor. The roof is a wooden truss covered with asbestos shingles and the windows are of wire glass. Although the heat from the fire was so intense on the mill side of the station that a man protected with wet sacks could stay there but a few seconds, the wire glass windows withstood the test. The glass was cracked in many places but did not fall out, which is the only reason that the station equipment was not damaged. If this fire had penetrated to the rear of the switchboards, which stand closely to the windows, it would probably have so badly short circuited the bus and feeders that the system would have been tied up for a much longer time.

The fuel bin, conveyor house and conveyor machinery was almost totally destroyed by this fire. These buildings were wooden structures and could not be saved when the water supply ran out, due to the destruction of the gate to the log pond. In addition to this about 1500 feet of poles and feeder circuits running from the power station toward the step-up substation some 2500 ft. distant were burned. The destruction of these lines interrupted service to the entire district, but due to the heroic efforts of the operating and construction forces they were temporarily rebuilt and service from the Springfield plant restored in less than twenty hours from the time of the interruption. In the meantime, a part of the Eugene load was carried by the Albany hydroelectric plant, some 45 miles away.

After the supply of refuse and hogged material from the Booth-Kelly mill was cut off, the company was compelled to burn slab wood shipped in from neighboring mills until a small fuel bin with a motor driven hog and chain conveyor could be completed. The slab wood is delivered from the cars to the hog, a cast iron drum containing a set of revolving knives which reduce it to very small chips. This is conveyed to the bins with one conveyor and from the bin to the Dutch ovens over the boilers in another. The

increase in evaporation from hogged slab wood over unhogged slab wood is about 15 per cent. This improvement in efficiency, as well as the saving in handling expense, fully warranted the investment in this equipment.

As an insurance against interruption of service due to the possible burning of the mills which are now furnishing slab wood to the power company, all the boilers are being equipped with an oil-burning system having an oil storage capacity of 50,000 gallons of fuel oil in two steel drums buried underground near the boiler room. This supply of oil will carry the present load for about two weeks. The oil-burning system will not only serve as a relay when the supply of slab wood is interrupted but will be used in conjunction with the hog-feed when sudden increases in load make unusual demands on the boilers that cannot be taken care of quickly enough with hog-feed. The burners are installed in the rear of the furnace, the flame being projected toward the front where the cone-shaped pile of hog-feed is burning.

Transmission.

Power is generated at 2300 volts at Springfield as well as the other power plants and is transmitted at 33,000 volts over the longer lines and at 11,500 over the shorter, being subsequently distributed at 2300 volts. No. 4 solid copper wire is used for the 33,000 volt lines which are designed for an ultimate voltage of 66,000. No. 2 bare wire is used for most of the 11,500 volt transmission, though there are 12 miles of No. 3 aluminum between Albany and Corvallis. Cedar poles and fir cross-arms are used throughout, the 33,000 volt line also carrying the 11,500 volt conductor beneath the high tension wires for most of its distance.

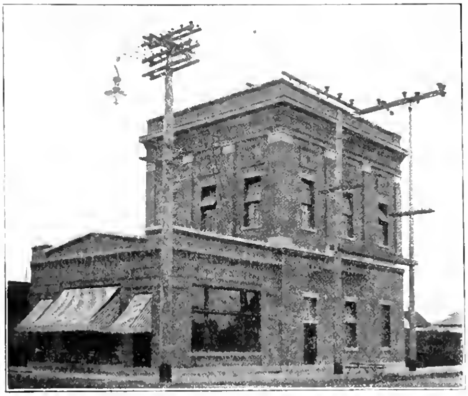
Power from the Springfield steam plant is taken at 2300 volts, 2500 ft. to the Springfield substation through two sets of 300,000 circular mil copper conductors, another feeder being used for local distribution. This station has two banks of three 500 kw. General Electric water cooled transformers, one bank raising to 11,500 volts for transmission 3½ miles to Eugene and 15 miles to Harrisburg, and the other bank to 33,000 volts for transmission 45 miles to the Albany substation. The same pole line carries the 33,000 and 11,500 volt conductors to Harrisburg where the latter terminate. From Harrisburg a 2300 volt line runs to Junction City, four miles distant.

At Eugene a small brick substation has been constructed in which are installed three 500 kw.-11500-2300 volt step-down transformers, one 300 kw. synchronous motor generator set furnishing 500 volts direct current to the street railway system (independent) in Eugene, and one 100 light tub transformer with all necessary feeder panels and arresters.

The Albany substation is similar in design to that at Springfield and steps down from 33,000 to 2300 volts for local distribution and to 11,500 volts for transmission back over the same pole line to the towns of Tangent, Shedds, Halsey and Brownsville. Another 11,500 volt line runs 12 miles from Albany to Corvallis whence it extends seven miles to Philomath.

With the exception of the main substations at Springfield, Eugene, Albany and Corvallis, all voltage transformations are made at open air pole-type transformer stations, voltage being reduced from 11,500 to 2300. The lighting circuits are 110-220 volt three-wire in congested districts and two wire in the outlying territory.

Automatic oil switches with inverse time limit relays are connected on both the low and high tension sides of the transformers in the main substations which are also equipped with aluminum cell lightning arresters mounted on the upper floor with the high



Springfield Substation.

tension switches. The incoming and outgoing high tension lines enter through roof insulators attached to conical concrete supports of local design.

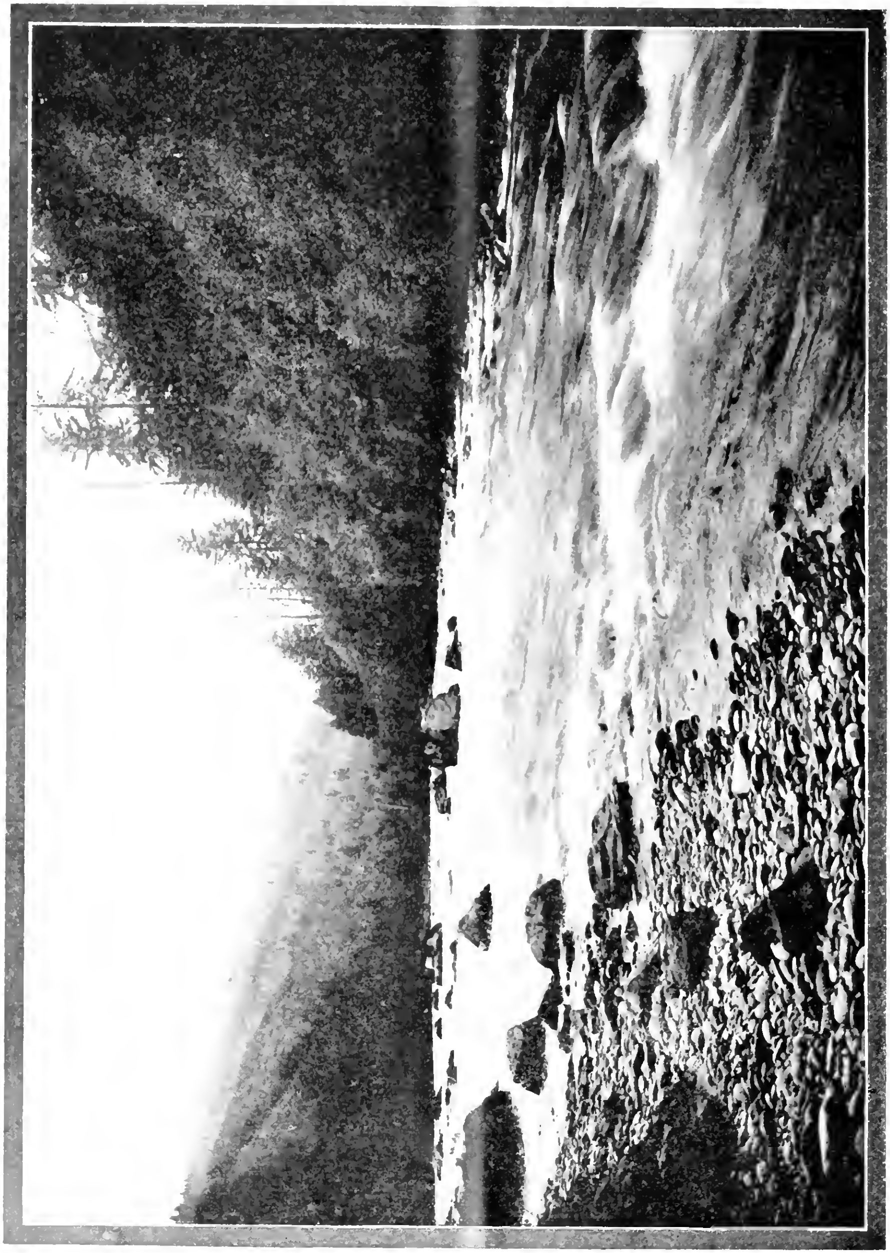
The Albany Plant.

The generating plant at Albany consists of one 200 kw. and one 300 kw. General Electric, 2300 volt, three-phase, 60 cycle, revolving field generator belt driven from a line shaft. This shaft in turn may be driven either by two 350 h.p. Platt Iron Works horizontal turbines operating under an average head of 25 ft. or by a 400 h.p. Bates-Corliss engine. Steam is furnished by three 150 h.p. Cahall water tube boilers. The engine and boilers are put into service only when the Springfield-Albany service is interrupted.

The Dallas Plant.

The steam plant at Dallas is not yet tied in with the main transmission line and serves the towns of Dallas, Monmouth and Independence. The power plant adjoins the mill of the Dallas Lumber & Logging Company, where sawdust and mill refuse is obtained for fuel. The equipment consists of two 200 kw., 2300 volt, three-phase revolving field General Electric alternators belted to Corliss engines, one being an 18x48 Hoffman & Billings and the other 18x42 Lane & Bodley. A 5½ kw. exciter is belted to each of the generator shafts.

The steam is supplied by two 312 h.p. Babcock & Wilcox boilers and one 400 h.p. Stirling boiler, all equipped with Dutch ovens for burning sawdust. Fuel economy being no great object and condensing water being expensive, this plant is run non-condensing. Mill refuse is used only when there is not enough sawdust.



Oregon Power Company's Power Site on the MacKenzie River.

The Dallas plant will eventually be tied in with the rest of the system, thus giving 82 miles of transmission lines. The company owns a waterpower site in the McKenzie River which will be valuable whenever the power demands of the district warrant its development.

Aside from the lighting load, the company's chief consumers are the electric railways at Albany and Eugene, the various planing mills of the vicinity and an increasing number of irrigation pumping plants. Electric power is also used for pumping the water supply of Albany and Independence, these plants being owned and operated by the Oregon Power Company.

Eugene Gas Plant.

The company owns and operates the gas works in Eugene which supplies gas through a low pressure system (3 in.) to Eugene and a high pressure system of 5 lb. to Springfield. The Springfield gas is transmitted 3½ miles through a 4 in. line at 20 lb. pressure and then reduced to a distributing pressure of 5 lb. The new water gas plant, which has just been completed, has a daily capacity of 500,000 cu. ft. as against a daily capacity of 60,000 cu. ft. of the old gas plant, which it displaced. The new holder has a capacity of 150,000 cu. ft. which will supply the present needs of the two towns for over 48 hours. This large holder is supplemented with a small auxiliary holder of 20,000 cu. ft. capacity. Crude oil is used under the boilers for generating steam used in gas making and distillate is used in combination with the steam in the manufacturing process.

When this plant was taken over there were but 11¼ miles of mains which have now been replaced by 33 miles of large size, ample mains. A most aggressive campaign has been conducted to increase the number of consumers and the volume of gas required and a general reduction in rates has been effected.

The Oregon Power Company is under the control and management of H. M. Byllesby & Company of Chicago, M. D. Spencer being district manager at Eugene at the time this article was written. Subsequently Mr. Spencer took charge of the company's interests in northern Washington and has been succeeded by R. M. Jennings.

N. E. L. A. CONVENTION AT SEATTLE.

The annual convention of the National Electric Light Association will be held in the state armory at Seattle June 9 to 15, 1912. This building has a convention hall with a floor area of 6000 sq. ft. in addition to a gallery and two smaller meeting rooms. It also has an area of 8000 sq. ft. for exhibition purposes.

In addition to the technical and commercial sessions, the various manufacturers will present an extensive exhibit of electrical apparatus.

The railroads will give special round-trip rates from Eastern points with full choice of routing. W. J. Grambs of Seattle has charge of these arrangements locally.

As the association already has nearly ten thousand members a large attendance is anticipated at this first Western convention. The Pacific Coast members plan to make this the most notable meeting in the history of the organization.

PLANT VALUATIONS.[1]

BY W. D. SCOTT.

In the days of small industries, when it became necessary to take account of stock for the purpose of finding the standing of an enterprise, or in the event of a contemplated sale, the task was not one of great magnitude as compared with that of placing a value upon the property of any of the larger enterprises of the present time. Take for example, an inventory of a general merchandise business. An actual count and appraisement of the tangible property was limited to one, or at the most, a few buildings and their contents. There remained but the accounts receivable and accounts payable to complete the tangible property. There was but one intangible asset—"the good will" that something, the personnel of the business organization which had built up the standing of the business in the community which it served and which in turn, contributed to its existence.

Today we have a newer and larger term in more or less common use, to an extent synonymous with good will, "going value." This term means not only the feeling of the community toward any particular enterprise, but further represents the organization effort, the time, money and men spent in bringing from nothing a properly co-ordinated whole, which will perform the functions of any particular enterprise with maximum efficiency.

Take a large enterprise which has been established for any considerable period. Consider its tangible property and the number of points of valuation to be determined. We have book value, first cost in service, reproduction cost, and present value for property, which may be scattered over an area of thousands of square miles.

Let us first consider book value. It might at first sight appear as though the physical appraisement of a property should not consider this item, but there are two radically opposed systems of accounting which will influence any comparative figures.

There is the theory of accounting which has as a basis that plant, like matter, is indestructible: that a capital expenditure, once made, is permanent; and that even though the plant itself may have been replaced by new construction, the enterprise is entitled to charge such rates for its service as will enable it to pay a reasonable return upon its entire investment.

For instance, take as an example a railroad which had, in the early days of its development, built into a comparatively unsettled community. The roadbed was of necessity lightly constructed, the grades were heavy, the bridges were light. Had this sort of construction not been placed, the enterprise would not have been able to sell its transportation at a figure which would attract the maximum traffic and pay a reasonable return upon the investment.

The community grows, and to provide adequate facilities for the increased traffic, it becomes necessary to replace the light bridges, reduce the grades and perhaps change entire stretches of the right-of-way. Now it is argued that without the first track, those light bridges and the heavy grades, this second and improved construction could not have existed. Hence,

[1] Paper presented before Portland Section, A. I. E. E., October 17, 1911.

a rate should be charged for the present service rendered, which will not only pay on the existing investment, but the present rate for service should include an earning on the capital investment made on the original plant, although the original plant may have disappeared.

In counter distinction to the foregoing is a system of accounting which considers providing a fund to be laid aside out of earnings, that will provide for new plant, when existing plant has to be replaced because of inadequacy, obsolescence and decay or deterioration from natural and usual causes. In theory with this system of accounting, the plant is always maintained at a point near its cost in service value, through maintenance.

It has been held that the item of depreciation should be applied to keeping a property up to its in service value, but some of the larger corporations have considered that the term depreciation covers only such expenditures as are to be made to cover expected replacements necessary, through inadequacy, obsolescence and decay or deterioration; as previously mentioned. Repairs cover such expense as is necessary to replace short lived parts, or to otherwise keep the property in a state of proper operating efficiency. Repairs to be taken care of from current earnings and to be considered as a direct operating expense—while depreciation is taken care of from a fund set aside out of the earnings and gradually allowed to accumulate during the useful life of property.

An instance is called to mind concerning a municipal investigation covering rates of a public service corporation, in which the statements of its experts in the rate making regulation were contrasted with the statements of the same experts at a previous inquiry regarding taxes. It was a hard matter to make clear to the investigating body why a property might justly have one value for rate adjustment and another quite lower value for the purposes of taxation.

First cost in service valuations will apply more generally to the affairs of the company itself, and serve as a check upon the actual construction of the plant. Their greatest value aside from their use in preparation of cost studies for additions is that of placing an original value upon plant displaced through new construction. In order that the book value of any property may be in strict accordance with the actual plant, it is necessary to credit the construction account with such removals as may be made from time to time. This credit should represent in value what such plant cost originally and it should include all charges both direct and indirect, which have entered into the cost of the work. It is not sufficient to credit the construction account with the bare cost of labor and material, but other expense such as general office, supervision, engineering and interest on the sum invested during the construction in process period, should be added to the bare expense of actually performing the work.

Reproduction cost, or as it is sometimes defined, the cost to reproduce new, is the value more generally [illegible] in preparing figures for a physical valuation of a property. In order to arrive at such [illegible] cost figures, a detailed summary of all [illegible] composing the physical plant, such as material [illegible] on hand, equipment, buildings, property and rights of way, together with their respective costs taken as of a certain date, are summarized to accord with the plant and property as it exists at that date. Such a compilation of data might be called an inventory, and falls logically into four distinct parts: the collection of field data, the making of summaries, the appraisement, and the determination of the amount of construction in process.

In making the appraisement, if figures representing the unit cost prevalent at the time the valuation is prepared, are used, some items will be found which cost more to construct at the time of their placing in service, than they would at the time of taking the inventory, due to advancement in the art or improved organization methods. As a balance against this there will be other items which undoubtedly are worth more in the present instance than they were at the time the construction was placed. For instance, it might be cited that should, through municipal legislation or far sightedness, a public service corporation place underground construction on unpaved streets, which, after the laying of this construction, were paved, it would be only right and just that the corporation in question should have the right to consider the underground construction so laid, as to have appreciated in value by the additional cost which would be entailed should it be necessary for them to place this construction in pavement rather than in the unpaved streets as was originally done.

It is thought that lack of consideration of this just appreciation has existed in various rate inquiries and that in one or two instances the investigating bodies have not allowed for this appreciation, but when it is considered that in the taxation of any property, its accrued value, due to the growth of the community is used as a basis of assessment, it would appear no more than just to allow for appreciation of properties in the taking of inventories on physical equipment.

After having obtained the necessary data and placed upon it a value, the serious question of depreciation must next be determined. Considerable misunderstanding has existed with regard to the term depreciation and the term is used in more or less contradictory language even in court decisions. Webster defines depreciation as "the act or state of lessening the worth of," and the depreciation of a property should not be confused with the method of laying aside funds for its ultimate replacement. While the fund may be called depreciation reserve, or it may be called replacement reserve, this fund itself should not be confused with the actual lessening in worth of the property.

Some of the larger corporations have carefully estimated how long the various units which go toward making up their entire plant will remain in service—not alone wearing value, but also considering the time at which the particular part of the plant under consideration, will of necessity have to be replaced, through inadequacy, or improvements in the art. It is often, in larger projects, impossible to estimate on an original investment beyond a given period, because if this is done, too large a capital expenditure would be necessitated in the first place, and it becomes preferable to take a basis of 15, 20 or 25 years as the replacement period for some of the particular portions of the plant; not because these particular items have

become defective through [illegible] would have become inadequate through growth of the community, or obsolescent through improvement.

It has been suggested by some that in a large corporation it is unnecessary to set aside a depreciation fund—that the plant as a whole would be so large and contain so many different parts which are being replaced from time to time that the depreciation fund becomes unnecessary, and that repairs made out of the current earnings will take entire care of the lessening in worth of the property. With any large plant at the present time, particularly those of the electrical industry, the development of the art has not reached such stability as will permit of any such gradual renewals. In fact, it might be generally assumed that there are cycles of replacement periods, and that should no fund have been provided as a reserve for replacements, for two or three years during these extensive replacement periods the dividend and earning power would be greatly impaired.

It is thought, in connection with a plant valuation, the figures of which are to be used in connection with the matter of establishing rates, that no depreciation should be allowed below an [illegible] value—that is, to maintain an efficient operating [illegible] and to give satisfactory service, the plant [illegible] be allowed to depreciate [illegible] reproduction cost. [illegible] the figures prepared be used as a basis for [illegible] the property should be allowed to [illegible] sale value. In other words [illegible] should be taken as a basis for [illegible]

The Ford Franchise [illegible] of the State of New York has taken [illegible] allowed, in the fixing [illegible] rates [illegible] their underground [illegible] on an annual depreciation [illegible] portions of the plant [illegible] a 10 per cent value [illegible] that a 75 per cent value [illegible] ing that an amount [illegible] of the mechanism that [illegible] ciate beyond 75 per cent [illegible] impossible to render efficient [illegible] part of the equipment [illegible] ical properties, it [illegible] no relation whatever [illegible] poration may have [illegible] rates for service [illegible] based on the amount of the [illegible] reserve funds.

In conclusion [illegible] engineer must recognize [illegible] actually is, and make [illegible] that have been worn out [illegible] should not be misled into including [illegible] value. In order to make the present value figures for any inventory or actual worth, it is necessary that the plant as a whole be carefully investigated and that particular attention be paid to the matter of present value. This can only be arrived at by an actual examination of the property in question by persons thoroughly familiar with all of the features of the particular enterprise under consideration.

UNITED STATES OIL INVESTIGATION.

[illegible] States [illegible] Mines, in following [illegible] petroleum, has just issued [illegible] on the Physical and Chemical Properties [illegible] of the San Joaquin Valley, California [illegible] In [illegible] which are [illegible] by the Bureau of Mines, the authors say in their [illegible]:

"Realizing the great importance [illegible] application [illegible] and its products for fuel, lighting and [illegible] and the absence of authentic and comprehensive [illegible] in the literature on the [illegible] petroleums, the United States [illegible] Survey has for a number of years [illegible] examinations of these [illegible] In 1907 the technologic [illegible] began a study of certain [illegible] with the natural [illegible] of the investigations was [illegible] value of the petroleums [illegible] of the United States, with special [illegible] in the public lands, and [illegible] be utilized in the [illegible] and greatest efficiency. [illegible] Bureau of Mines [illegible] include the [illegible] information as [illegible]

[illegible]

TEST OF WESTERN CEDAR POLES.

The results of an exhaustive series of tests on the strength of round cedar poles are so contrary to the general notion as to make a brief summary of interest to all pole users. The tests were performed under the supervision of A. H. Griswold, plant engineer of the Pacific Telephone and Telegraph Company, R. T. Joslin being the inspecting engineer in charge.

Heretofore, poles for use in the Western States have been purchased upon the basis of Eastern specifications and it has long been suspected that the pole strength exceeded service requirements. These suspicions were more than confirmed by the tests and as a consequence the company has issued a new set of specifications which will bring about a great saving in the cost of poles purchased.

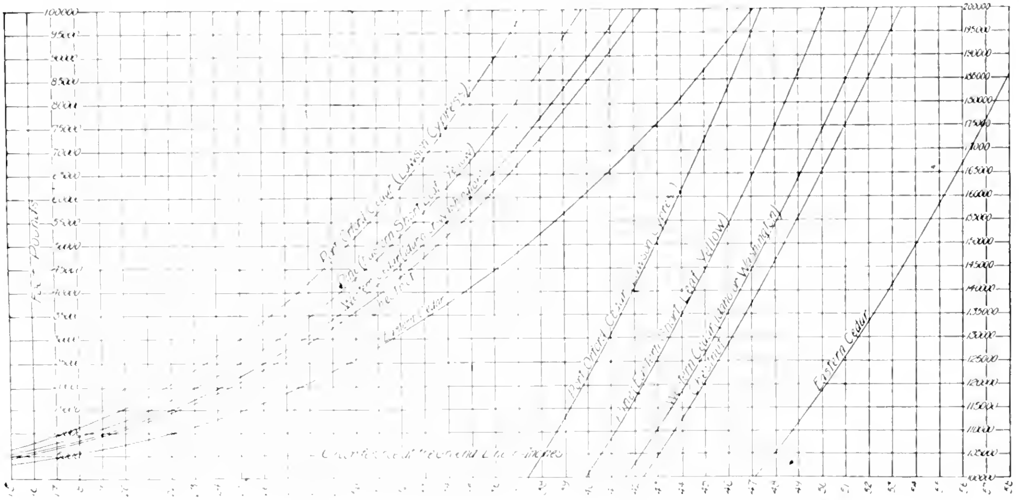
During the test every endeavor was made to duplicate actual field conditions. The poles were of round cedar, with sapwood, stripped of bark. Six feet of the pole was rigidly held so as to act as a beam solidly encased at the ground line. The pull, as horizontally applied near the top of the pole, was measured by a direct reading dynamometer, carefully calibrated.

The observed data included a measurement of the top deflection, the moisture content at the point of failure, the pole dimensions and weight, and the dynamometer reading at the time of fracture of both sapwood and heart. Photographs were taken in each case to show the character of the fracture and the modulus of rupture was calculated from the observed data.

In all, 81 poles were tested, there being an equal number of Western cedar from Idaho, Port Orford cedar from Oregon, and Western cedar from Oregon and Washington. These were segregated into 25, 30 and 35 ft. lengths of 6, 7, 8 and 9 in. top, were summer cut and well seasoned. In each case the data were carefully tabulated and individual curves were drawn to show the deflection at the various loads. The average results in each case were as follows:

Kind of Pole.	Modulus of Rupture.	Per cent Moisture Content.	Per cent of Sapwood Area.	Rings per Inch.	Weight per cu. ft. in lb.	Load at Failure
Western cedar from Idaho	5268.53	10.1	26.254	20.324	22.741	2214.31
Port Orford cedar from Oregon	7218.38	12.061		15.99	26.654	3039.43
Western cedar from Oregon and Washington	5353.185	15.152	33.99	11.933	21.947	1928.666

The principal sources of weakness in Western cedar in order of their importance seemed to be (1) Injury to sapwood due to teredo pitting, bark trimmer's ax cuts or bruising; (2) rapid growth; (3) excessive sapwood; (4) weather checks; (5) knots; no center rot was encountered.



Graphic Computing Chart Showing Pole Circumference to Withstand Rupturing Moment.

The results show that Port Orford cedar is superior to Western cedar and also that it gives a more consistent performance, due probably to its uniformity in age and quality. Weather checks are an important factor in the weakening of Port Orford cedar and rapid growth makes a weak pole. The average of all these results have been summarized and combined with similar observations by the American Telephone and Telegraph Company on the accompanying chart, whose curves show the moments required for rupture of the various classes of round wooden poles.

From this chart it is possible to directly read the size of pole necessary to withstand a given pull. For instance, a 30 ft. pole subjected to 2000 lb. pull will have a moment of 60,000 ft. lbs. Following the 60,000 line to its intersection with the Port Orford cedar curve, we find that a pole having a circumference of 31.7 in. at the ground line will suffice, while Eastern short-leaf yellow pine requires 33.6 in., Western cedar from Idaho or Washington 35 in., chestnut, 35.7 in., and Eastern cedar 40.8 in.

"NEW BUSINESS" METHODS FOR THE SMALL CENTRAL STATION[1].

BY ARTHUR GUNN.

"New Business" methods, as its name implies, is the process of securing new business, and thereby increasing the revenue and usefulness of the central station. In every company, the "New Business" getting is so closely connected with other departments of the business, and particularly so in the small station where the entire management devolves on one man, that it is impossible to discuss the methods in this department, without incidentally, at least, touching on some features which might technically be considered to lie outside of the subject.

By a "small" central station we may consider as defined the company which is too small to have an executive staff, and where the responsibilities of all departments rest upon one man as manager. One adadvantage at least can be said to pertain to this arrangement—all departments are in close relation and harmony with each other. Such a manager does not have to contend with departmental indifference and jealousy which is often a serious factor of trouble in larger companies.

"The man behind the gun" is an essential element in this, as every human problem. Let us first take stock of our manager. He must be a man of excellence in many characteristics, for to succeed he must show ability in many directions. The man who has the essential characteristics to make a really successful manager for a small central station is the best possible timber for manager of a large one—and to that position he may well aspire to attain, either through the development of his small company into a large one, or from opportunities rising from the notable character of his work. Successful managers of small plants are not so numerous as to be individually inconspicuous from their number.

I would name as the essential characteristics of such a man

Dissatisfaction,
Ambition,
Intelligence,
Information,
Industry,
Tact,
Perseverance,
Courage,
Commonsense.

Rather a formidable list is it not? And yet the absence of any of these is a serious handicap. He must be perpetually dissatisfied with what he is and what he has accomplished—he must not "get stuck on himself." He must have ambition for greater and better things. He must have intelligence, and must have, or obtain, information. It seems almost a jest to say that the man with so many things to do should be industrious, but in this connection we are reminded of the witty preacher's definition of a lazy man as "The fellow who spends so much time doing what he wants, that he has no time for doing what he ought." And finally in dealing with his consumers, actual and prospective, he certainly will need tact, perseverance, courage and common sense.

[1]Paper presented at Spokane meeting Northwest Electric Light and Power Association.

Now let us take the case of the average small central station, in which one man is manager, superintendent, sales agent, and perhaps lineman and station operator. We will assume that this man is fairly qualified for his position, that is, that he has a fair working knowledge of the business. How can he best increase the business of the company?

First: He must bend his energies to giving satisfactory service.

The customer of an electric light and power plant is paying his money in the expectation of receiving a certain definite commodity. That commodity is electric energy to be delivered continuously for certain hours during each twenty-four, at an agreed voltage, and within agreed limits as to quantity. Uninterrupted service, and regular voltage are essential. While opration does not properly come under the head of "New Business," "New Business" succees is so dependent upon it, that we are justified in mentioning it. Our manager of the small plant will keep his lines and generating station in the best operating condition and efficiency of operation that faithful effort and the means at his command will allow. He will take care of all trouble as promptly as possible. A consumer left in the dark for a single night through the fault or negligence of the company never feels that any credit is due the company for the service furnished for the rest of the year. Meter reading and testing have an important bearing on the relations between the company and the consumer. A discourteous meter reader can make more trouble for the company in one month than an accommodating manager can straighten out in six. Too much care cannot be taken in handling complaints. A complaint properly handled to the satisfaction of the consumer will do as much toward getting new business for the company as any other method which the company may employ.

Our manager must have tact and courtesy.

Too many managers of plants big and little appear to assume that in furnishing service to their customers they are conferring a favor, and are dictatorial and even rude in their treatment of them. The true statement is that he is giving value for value received, and his motto should be "Charge what the service is worth, and deliver all that the customer pays for." If he is convinced that his rates are fair, and proportioned to the cost of service, he has nothing to apologize for and should never allow himself to be put upon the defensive or in an apologetic attitude. But he should remember that the difference between a large consumer and a small one is a difference in quantity and not in quality, and that his duty to each is equally great. Every customer is entitled to be treated as courteously as though he were the most important patron which the company had, and that it was absolutely necessary that the company should have his business.

The successful "New Business" man will constantly live in the atmosphere of his work. He will rise with it, stay with it, go to bed with it and sleep with it. To illustrate: The manager in a town of a thousand people, near here, who has been very successful, writes: "I know of no special methods of getting business in a small town only to put in every

minute working. On my way to and from work I call on prospectives. I also do soliciting right along with my wiring work. Sometimes I take men and tools and materials right up to a house; estimate and wire it. I have gotten the very hardest ones to come through by this method, as there seems to be a sensitiveness about being passed up for the next neighbor." This man certainly lives in the atmosphere of his business, and exhibits well directed energy and a keen judgment of human nature as well.

Of the uses of electric energy there are no end, and in this paper we deal with general principles rather than with details of specific apparatus. The electric iron has become almost universal—electric cooking devices are plentiful. Power applications are limited only by the ingenuity of the "new business" man and the size of the field. Electric soldering irons, glue melting pots, vulcanizers, heating pads, milk warmers, fans, and other apparatus can be put out in even the smallest communities. We give a few points which have been furnished us by various managers.

One writes: "Upon fitting out a house and turning on the lights, I call in the neighbors to inspect it. The people whom I have just lighted are more enthusiastic at this time than any other and will do more to help me to secure business than at any other time. Unless I sell an iron and a toaster outright I place them on trial for thirty days. I advertise the cost per hour to operate the different appliances so there can be no misunderstanding. I try to keep everybody satisfied, because in a small town a good knocker can go the rounds in a very short time."

Another furnishes a good "don't" hint. "I never place an electric device which is an excessive current eater in the hands of a customer who is liable to fail to understand in advance the apparently excessive bills which will naturally follow such an installation."

Efficiency should be the motto of every installation. Seek to give the customer that from which he will get the largest possible return for his money. Never be tempted to load a customer up with an excessive power or lighting installation.

Seek to build up your business upon lines already constructed, rather than to spread out too fast in new construction. Work to the end of having every house and building reached by your lines connected, and the maximum economical use of electric energy at each location, rather than a widespread system with sparse connections.

For the rural town, investigate the possibility of the country line. The farmer's telephone lines have covered the country, and the farmer's electric lines should follow them. Many farmers will advance the cost of construction, part or all of which may be returned to them by applying it upon their bills. Farmers are liberal power users when convinced of its practicability and economy.

In working up business in a new locality or extension, avoid holding public meetings—work man to man. However enthusiastic a meeting may appear to be, it is usually, consciously or unconsciously, hostile to the man who has a scheme to present. The average American loves to make a speech, whether he has knowledge of the subject or not. In such a meeting, the ill considered remarks of your friends may do damage, and criticism and opposition are liable to spread like wild fire. No opportunity is given at the ordinary public meeting to "close up," and business not covered by a signed contract is not yet secured.

Last of all, never forget that "New Business" getting is for the purpose of making money for your company, and never be tempted to take on business at unprofitable rates, or of an unsubstantial nature where the construction expense may be a dead loss to your company if the consumer fails.

It is important that the manager who wishes to develop the use of electric energy should keep himself as fully informed as possible regarding the manifold applications of this agency, in the forms of power, light and heat. In his comparative isolation, the first and most natural source of information is the printed page. Every station manager should take and read not one, but several electrical publications advertisements and all. Indeed from the "New Business" standpoint, if he had to make a choice, we should recommend that he read the advertisements rather than the text. The flood of circulars and price lists which he naturally receives or which can be had for the asking, is also a source of valuable information—making due allowance for extravagant claims and fitness for his locality. If he has the intellect and common sense which his position demands, he will not be lead by a manufacturer's circular to order a pipe thawing transformer outfit if he is located in Florida—but he may note the value of a forge blower for his busy local blacksmith.

The periodical visits of the traveling salesman will be welcomed by the bright manager. More and more these representatives of the supply trade are men of technical ability and training, and gentlemen as well, from whom valuable information and practical suggestions may be obtained. They not only will keep him advised of the latest developments in the electrical field, but often will instruct and co-operate with him in sales campaigns which will be of the greatest benefit. The man who repels the traveling salesman for fear he may sell him something is dodging one of his best instructors.

Another great source of information, which perhaps can only be enjoyed in a limited way by many, is the observation which comes through travel. The great companies have scouts always on the move to learn the best methods and means by personal observation. But even the manager of the smallest company may visit the metropolis of his district once or more each year, and no such visit should be made without coming in personal contact with the representatives of the large companies in such city. Such visits are usually welcomed by these companies, for, though he may not realize it he will give as well as receive—for the very questions she will ask, may open up new avenues of investigation and profit for the larger companies.

Finally—the manager who cannot of himself realize and avail himself of the benefits of association work is an egregious ass—and is not the subject of our consideration.

CO-OPERATION.[1]

BY ALBERT H. ELLIOTT.

If any one proposed to you a plan of organization of the electrical business, which attempted to exclude self interest, you would be justified in treating such a proposal as chimerical and unreal. In any scheme which is put forward, we should be sure to keep our feet well anchored on the practical earth of business.

There is a distinction, of course, between self interest and selfishness. Selfishness is narrow, short-sighted and ends in its own undoing. Self interest is broad, deep, has a wide horizon, and looks to the great future, instead of the limited present. Self interest has built up this wonderful world of commerce, which buzzes and whirls about us.

The laws of trade and commerce are as old almost as the laws of the Medes and Persians. For many, many years, the channels through which goods are distributed from the manufacturer to the consumer, have been cut through the geological strata of the earth, and it is useless to attempt to dam up these channels or turn them aside by Act of Congress or Decree of Court. You can no more change the great economic laws of business, than you can stand with a broom at the Golden Gate and sweep back the on-rushing tide of the restless Pacific.

It behooves us therefore, to use the laws of commerce intelligently, and to find in the distributing system by which goods get from the manufacturer to the consumer, the best way which we can work under the law to produce the best results.

The group of persons who minister to the process which I have described, are fairly well defined. The manufacturers seize the raw material, and with skill and capital, produce the electrical goods.

The jobber displays the goods upon shelf and counter, maintaining variety where he may choose, and conveys the goods to the consumer.

The electrical contractor picks the goods off shelf and counter, and installs them in the home, the store and the factory.

The central station furnishes the current, without which the electrical goods would be of no use, and stimulates the consumer to a further use of the goods.

The electrical engineer gives expert information as to the best way of placing the goods and outlines the plan of installation.

Each group here described is a link in the great chain, and each link is necessary to the maintenance of the strength of the chain.

No group can stand up and with raised hands say: "We are the electrical business." The interdependence of one group upon another is so obvious, that it is but the statement of an elementary truth to say that all of those engaged in the electrical business are interlocked, interwoven, intertwined, so that the finished product is a great economic system by which goods are produced distributed and consumed. In fact, we have here, the genesis of electrical goods which may be compared to birth, the distribution and installation of electrical goods, which may be compared to life and the final consumption of electrical goods, when the goods are returned to earth from which all things, human and material first originated.

At this point, we come not unexpectedly upon the much used word "CO-OPERATION." Possibly some one of you may now shut your eyes and say "This is the same old theme." Yes, it is the same old song, but it is the song which is being sung now from one end of the country to the other. The doctrine of co-operation as a political theory, as a sociological doctrine, and as a commercial suggestion is is busying the mind of man.

I do not propose the old idea that man is his brother's keeper, in the charitable sense of that theme. Our plan is not a suggestion that we should do unto others as we wish to be done by, simply because we find it spoken of in the Great Book. We are prepared to demonstrate that co-operation is justified by any intelligent consideration of what we mean by self interest. It is all a matter of education.

No man is big enough to stand up and say "I will run my own business in my own way, without regard to what others in the same line of business are doing." Perhaps some of you have not yet been converted. Perhaps you have not experienced the change of heart, as they say at a religious revival.

Do you believe in team work? What we want in the manufacture and distribution of electrical goods, is perfect team work, so that all the groups who take part in the production and distribution of electrical goods, will present to the consumer a united and harmonious front.

It is not a question as to how the leaders in the business are doing, but the rank and file must work hand in hand with each other and the leaders. Our plan is ethical, because it excludes no honest man in the business and sets its face toward a policy which helps all and injures none. The plan is not fanciful, because those who have studied the matter are convinced that their ultimate self interest lies along the lines of perfect co-operation.

The consumer is included in the plan because he gets a better article at less cost and with better service. If you believe then in these principles, let us form a league where each branch of the electrical industry shall have complete representation.

The league can act as a clearing house for the settlement and adjustment of the many questions, which so vitally affect the business.

Charges of unethical business conduct may be heard and decided, and a future policy regarding the questions raised might be outlined. The league should be entirely democratic in character, and no better motto can be chosen than the one which we read of so many times, "altogether all the time for everything electrical."

If we become really enthusiastic and have faith and confidence in ourselves, our faith and confidence will become contagious and will reach the consumers. The consumers will judge our goods by the kind of people that we are.

A united electrical fraternity will lead the consumers to see that we are like our goods and our goods are like us. Co-operation is thus brought down from the clouds and made a reality.

[1]Address made at luncheon of representative electrical men at San Francisco, November 28, 1911.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

The result of this week's election at Los Angeles repudiate the claim that investments in that fair city's public utilities are hazardous, and should react favorably upon the financial standing of the municipal projects as well as the telephone, electric and gas companies.

The bull in the china shop is but a circumstance to the bear in the gas plant at Banning, California. Bruin escaped from a traveling circus, invaded the plant, frightened the engineer, threw off the governor belt and caused the engine to run wild. Inasmuch as the friction from the rapidly running belt burned his fore-leg, we assume that this bear will hereafter follow the example accredited to a burned child.

Central station men are greatly heartened by Secretary Fisher's sane view of the water-power question and trust that the Sixty-third Congress will act favorably upon his recommendations for new legislation. Government officials recognize the inadequacy of the present laws and their frank acknowledgement will soon turn the tide of popular opinion which has been raised by ill-advised conservation enthusiasts. The time is most opportune for all electrical men to write to their Congressional representatives to support the bills which are intended to ameliorate the present intolerable condition.

It has remained for a lineman in the employ of the Puget Sound Electric Company to demonstrate that a rifle is a necessary part of a trouble-shooter's equipment. A toppling pole, too dangerous to climb, threatened to pull down the Electron high-tension wires. The lineman, perhaps mindful of similar depredations of the small boy with his gun, shot away the porcelain insulators on the damaged pole and thereby released the line so that the pole could be pulled down without damage.

The Electrolier Law

The good people of Alameda, California are manfully endeavoring to assume the heavy responsibilities that rest upon the shoulders of a public purveyor of electric light and power. Fearing that possible collusion among bidders might cause them to pay an unduly high price for labor and material, they recently secured the passage of the so-called "electrolier bill" through the California Legislature.

Its provisions, while intended solely for Alameda, are of course State-wide in application. Its intent was most innocent, but its effect is so vicious and opens up such a wide opportunity for petty graft that it might well be repealed before the dangers hereafter indicated assume greater proportions.

Careful reading of the 14th and 15th sections of this law will show that any California city is thereby permitted to reject a responsible bid at a satisfactory price if the head of a city department believes that the work can be done more cheaply by that department. Suppose that a responsible contractor should

submit a bid, accompanied by a certified check, which is lower than the original estimate of say the city electrician. That individual then has the privilege of making a new estimate, naturally lower than that of the contractor, and the work is awarded to his department.

It is thus seen that the contractor is not only "up against a stacked deck," but that he is playing with an irresponsible dealer whose losses will be covered by an unsuspecting house. No municipal department can be held responsible if costs exceed estimates and the public seldom analyzes the reason for an additional assessment. This law consequently gives a city lighting department a complete monopoly on all work that it may desire to perform, without restriction or accountability as to cost.

As before stated, we believe that this bill was passed in all innocence and consequently its sponsors should be the first to urge its repeal after its manifest unjustness is called to their attention.

California Public Service Commision

The most important matter now before the special session of the California Legislature is the California Railroad Commission Act, which has been drafted in accordance with the recently adopted constitutional amendments. Its terms increase the membership of the commission from three to five and gives the commission complete control over the rates, character of service, valuation, accounting methods and stock and bond issues of all public utility corporations in the State, except such powers of control as are now exercised by the various municipal and county authorities.

The bill, as originally submitted, seems ultra-radical and in strict accord with the present sentiment that public service corporations are to be rigidly accountable for all actions. Its provisions might well be extended to include a similar supervision over municipally operated utilities, where the public is interested not only in the service but also in the costs of operation. Furthermore but a small proportion of the operating companies can be subject to the commission's rulings until several of the large cities assign the rate fixing powers they now enjoy.

Yet, on the whole, it is a step in the right direction and the several inconsistencies will be gradually eliminated in the course of time. Experience has shown that the establishment of such supervisory control gives a certain financial recognition and stability on account of the equal publicity to all corporation doings. In the hands of the right men a public service commission is capable of great good in the impartial settlement of all differences between the public and the company catering to its needs.

The recent revelations of weakness in the New York act should be carefully borne in mind before final adoption of the California bill. Because of its ambiguous wording the New York State Court of Appeals has shorn the New York Commission of its authority to approve or forbid the proposed stock and bond issues of public utility companies. All obstacles to the unlimited watering of these securities are removed and until the defects are remedied by a new law the investor is left without this much needed protection.

The framers of the California bill have been especially fair in inviting free and open discussion of all its features. With a few notable exceptions, however, the central station men have been slow to take advantage of this opportunity to make desired changes before the law's final passage. If they find their future plans unnecessarily limited by its provisions they will have but themselves to blame.

Recognition of the Engineer

This week has witnessed the most significant event in the history of engineering. A movement, broad in purpose as in method, has been started whereby the engineer is to be made a vital, essential factor in the world's every-day life. Live men, not dead materials, are to be the means of rearing the new social structure now so necessary.

The American Society of Mechanical Engineers has entered the field of social service. Its committees will investigate the conditions in each of the great industries, will devise means of betterment and will put them into execution. Their call will waken the greatest, and also the sleepiest, giant this old earth has ever known. The abilities of the engineer will be brought to cope not only with these industrial questions, but also with the problems of municipal, State and national affairs. Incidentally this public service, and this alone, will bring about that recognition to which the engineer has long thought himself entitled.

Even Mohammed finally realized that his powers could not transcend the ordinary laws of nature. He went to the mountain. Likewise the engineer at last appreciates that the public does not accord recognition to those whom it does not know. The mere possession of such merit without applying it to the public welfare is as futile as the ownership of an undeveloped gold mine, notwithstanding the owner's little self-complacency.

The engineer has "wrapped his talent of silver in a napkin," whereas the other learned professions, to whose emoluments he has aspired, have given their talents to the public service, albeit full monetary return has been exacted therefor. Ministers and doctors as well as lawyers, those who save our souls and those who save our bodies as well as those for whom we save our money, are to be ousted from their monopoly in the public's confidence.

The machinery by which this beneficient revolution is to be set in motion consists of a number of committees working under the able direction of Dr. Alexander C. Humphreys, president of the Society, of Stevens Institute and of the Buffalo Gas Company. Membership in these committees is open to those best qualified without regard to Society membership.

In order that these ambitious plans be carried to a successful culmination, it will be necessary for all broad-minded, well-meaning men to join this movement. Similar concerted action is necessary on the part of the other engineering and scientific societies. Too long has the engineer hidden his light under a bushel and here is a golden opportunity to lighten the labors and problems of the world.

PERSONALS.

H. B. Squires, of Otis & Squires, is at Los Angeles.

George E. Binckley, hydraulic engineer at Los Angeles, is at San Francisco.

Arnold Pfau, hydraulic engineer with Allis-Chalmers Company, is at Los Angeles.

A. W. Burchard, of the General Electric Company, is visiting the Pacific Coast.

A. F. Hockenbeamer, secretary and comptroller of the Pacific Gas & Electric Company, is at New York.

S. N. Griffith of Fresno, a promoter of electric railroads, is at San Francisco in the interests of a new project.

Nicholas Gilman has been appointed city engineer at North Yakima, Wash.

H. H. White, general manager of the Everett Gas Company, has been transferred to the management of the Tacoma Gas Company.

S. V. Mooney, manager of the Pacific Coast branch of John A. Roebling's Sons Company, has returned to San Francisco from an interior trip.

J. B. Lukes, general manager, and E. B. Bumstead, an engineer of the Reno Power, Light & Water Company, were recent arrivals at San Francisco.

S. L. Shuffleton, northwest manager for Stone & Webster, has been in conference at San Francisco with regard to the establishment of San Francisco offices for the company.

P. H. Ridgeway, formerly associated with the Electrical Engineering Company of Seattle, has opened offices as consulting and constructing engineer in the Central Building, Seattle, Wash.

E. V. D. Johnson, manager of the Northern California Electric Company, with headquarters at Redding, has been spending a few days at San Francisco, accompanied by W. G. Moores, the assistant manager.

R. G. Berle, secretary and treasurer of the Symonds-Berle-Kirkpatrick Company, is at Los Angeles, with the intention of opening Pacific Coast offices as the representative of a number of Eastern electrical and machinery manufacturers.

J. W. Burke, the chief civil engineer of J. G. White & Co.'s staff, arrived from New York during the past week to inspect the work in progress on the new 3,000-foot tunnel on the line of the Oakland & Antioch Railway, extending through the Berkeley hills into Contra Costa County. This work is being done by Shattuck & Edinger, contractors, under the general supervision of J. G. White & Co.

C. E. Patton, representing the Central Electric Company of Chicago, visited the trade at San Francisco during the past week. He formerly confined himself to Southern California, Arizona and southwestern territory, but since James Irvine, who was at the head of the company's Los Angeles agency for the past two years, joined the Lorbeer Electric Supply Company of Los Angeles, Mr. Patton has extended his territory. His principal lines are Okonite wire and Opalux glassware.

John A. Britton, general manager of the Pacific Gas and Electric Company, gave an address last week before the Mission Promotion Association of San Francisco on the subject of the "Improved Gas Conditions in San Francisco." Fifty lantern slides were used to show what had been accomplished in the way of betterments. One slide showed the new five-million cubic foot gas-holder at the Potrero gas works placed side by side with the St. Francis Hotel. The holder, which is nearing completion, is 226 feet in height and 201 feet in diameter and cost $382,000. It is 46 feet higher and only 16 feet narrower than the Powell-street front of the hotel.

OBITUARY.

Caryl Davis Haskins, manager of the lighting department of the General Electric Company, and one of the best known electrical men of this country, died Saturday morning, November 18th, in Salt Lake City. Mr. Haskins was stricken with pneumonia while on a business trip in the west and the end came unexpectedly. The body was removed to Mr. Haskins' home at Schenectady, where a brief funeral service was held Wednesday, November 22d, temporary interment taking place at Schenectady. Mr. Haskins was born in Waltham, Mass., May 22, 1867, and was educated in England where he specialized in mathematics and physics and took a special course in surveying and fortification work. Early in 1887 he entered the employ of the firm of Haskins, Davis & Company, mechanical engineers, of London and Boston, Mass. Here he applied himself to engineering work on early gas engines and special bookbinding machinery. In 1883 he entered the employ of the S. Z. de Ferranti & Company as one of its junior assistant engineers, where he had charge of the manufacture of electrical meters and assisted Mr. de Ferranti on the drawings for the original Deptford electric light station.

Carl Davis Haskins.

In the autumn of 1889 he entered the employment of the Thomson Electric Welding Company, Lynn, Mass., as designing draftsman. Two or three months later he was employed by the Thomson-Houston Electric Company, Lynn, Mass., as an electrical engineer. In 1891 he was appointed manager of the meter department of this company and after its consolidation with the General Electric Company Mr. Haskins retained this position, including general supervision of the engineering and manufacture of instruments.

At the beginning of the Spanish-American war Mr. Haskins proffered his services to the government and organized a corps of electrical engineers and men trained in electrical work, of which he was made commander. At the conclusion of the war Mr. Haskins resumed his position with the General Electric Company. He has made a special study of electricity as applied to offense and particularly defense in time of war and was considered an authority on this subject, and after the close of the war he frequently acted in an advisory capacity to the government in matters of this nature.

Upon coming to Schenectady eleven years ago, Mr. Haskins was given charge of the electrical switchboard industry

of the General Electric Company, and in 1906 was appointed manager of the lighting department of the company.

Mr. Haskins was greatly beloved by all his associates and had an unusually wide circle of friends who will long cherish the memory of his charming versatility and brilliant intellect. He was well known as the author of many technical papers before the various engineering societies and was always in demand as a lecturer at various technical colleges and institutions. He was known in the literary world as the author of several standard works on electrical subjects, and was also the author of a number of successful short stories.

MEETING NOTICES.

On account of the Christmas holidays there will be no December meeting of the San Francisco Section of the American Institute of Electrical Engineers.

"Public Service" is to be the subject of discussion at the December 19th meeting of the Los Angeles Section of the American Institute of Electrical Engineers. Addresses will be made by T. B. Comstock, engineer for the Los Angeles Board of Public Utilities and Paul Shoup, vice-president and general manager of the Pacific Electric Railway Company.

The first of the series of regular monthly luncheons to be held by the Portland Section of the American Institute of Electrical Engineers, took place at the Imperial Hotel restaurant on December 5. The Portland Section has recently arranged to have its papers printed in these columns, and whenever papers can be prepared far enough in advance they will be printed so as to antedate the meeting, thus paving the way for a more intelligent discussion

ELECTRICAL MEN'S LUNCH.

Pursuant to the wishes of the electrical men of San Francisco as expressed at the recent luncheon, the temporary committee, consisting of S. J. Lisberger, H. V. Carter and E. B. Strong, selected an advisory committee to draw up a constitution and bylaws and to nominate officers. This committee consists of C. C. Hillis, T. E. Bibbins, W. W. Briggs, John R. Cole, W. W. Hanscom, W. S. Hanbridge and W. F. Nieman. They will report at a lunch to be held at Tait's Cafe on December 12 at 12:15.

As this is to be the first regular meeting of the new electrical clearing house, it is the unanimous wish of the committee that every electrical man attend. It is especially important that each craft should have a large representation, and those who cannot attend the lunch are urged to participate in the subsequent meeting, which will be called to order at 1 o'clock.

RAILROAD DINNER AT PORTLAND.

A dinner is to be given at the Portland Commercial Club on December 16 to the new railroad officials of Portland and the State Railroad Commissioners. The former include Carl R. Gray, president S., P. & S., Oregon Trunk, Oregon Electric, United Railways and Spokane & Inland Empire R. R.; J. D. Farrell, president O.-W. R. & N. Co.; S. G. McMeen, president Mt. Hood Ry. & Power Co.; C. A. Coolidge, vice-president and general manager Spokane & Inland Empire R. R., general manager Oregon Electric and United Railways; W. N. Porter, treasurer Mt. Hood Ry. & Power Co.; F. W. Hild, general manager P. R., L. & P. Co.; D. W. Campbell, general superintendent Southern Pacific Company; J. M. Scott, general passenger agent, Southern Pacific Company; H. E. Lounsbury, general freight agent Southern Pacific Company; G. H. Smitton, assistant general freight and passenger agent Great Northern Railway; W. P. Warner, district freight and passenger agent, C., M. & P. S. R. R.; J. H. Mulchay, assistant general freight agent Southern Pacific Company; A. B. Hutchinson, purchasing agent Southern Pacific Company, and G. W. Saul, purchasing agent O.-W. R. & N. Co.

The following are members of the various committees: General arrangements, Guy W. Talbot, A. M. Shannon, A. O Jones, D. O. Lively and E. H. Ransom; invitation, Hugh Hume, Guy W. Talbot and F. C. Malpas; attendance, J. W. Minto, J. E. Webb, J. P. Porter, M. L. Kline, J. S. Ball, G. J. Major, F. S. Doernbecher, J. Louisson, and Phil Metschan, Jr.; speakers, F. C. Malpas, C. K. Williams, H. S. Tuthill, D. T. Honeyman, H. L. Corbett and R. L. Macleay; entertainment, J. Fred Larson, W. A. Montgomery, L. A. Colton, Hugh Hume and V. Vincent Jones.

THROOP SCHOLARSHIPS.

A friend of Throop Polytechnic Institute, of Pasadena, California, who believes in the educative value of travel, has established two scholarship awards, to be known as the Senior and Freshman Scholarship Prizes, respectively. The Senior Scholarship Prize, consisting of $750, to be expended in a trip to Europe, is awarded to that member of the graduating class who has the best record in scholarship for the junior and senior years, the faculty taking also into account, in assigning the award, considerations of deportment, or good manners, and ability for original work. The Freshman Scholarship Prize, consisting of $250, to be used in a journey through some of the principal cities of the Eastern United States, is awarded on each commencement day to that member of the freshman class who has the best scholarship record for the year, good manners and the quality of initiative being also taken into account.

OREGON CONTRACTORS ORGANIZE.

Oregon members of the National Electrical Contractors' Association are arranging for the establishment of a state association. Fred W. Webber, state electrical inspector, acting as chairman, has appointed committees to draw up a constitution and bylaws.

ELECTRICITY ON THE SUNSET LIMITED.

The electrical equipment of the Sunset Limited, which the Southern Pacific Company is again running semi-weekly between San Francisco, Los Angeles and New Orleans, is one of the most important features of the new train de luxe. Electric lights, fans, telephones, appliances for barbers and hair-dressers, as well as electrically operated block signals contribute greatly to the comfort and safety of travel on this train, which brings New Orleans one day nearer to the Coast. Thousands of dollars have been expended by the railroad company in an effort to make the "Sunset Limited" a peerless conveyance for the discriminating transcontinental traveler. The all-steel Pullman cars which compose the train have been especially constructed for this new service, and all elaborations have been made with the idea of insuring the comfort of "Sunset Limited" patrons.

TRADE NOTES.

The first Francis turbine unit of the Pacific Coast Power Company's White River plant near Tacoma, Wash., is now in commission. The Allis-Chalmers Company report that this 15,000 kw. machine is being excellently governed by their new design of pressure regulator, and is taking care of the pressure fluctuations of the entire system.

L. F. Yondall, manager of the Electric and Machine Equipment Company of Stockton, is rebuilding two pumping plants for Irrigation District No. 684. He will install a 150-h.p. Westinghouse motor and transformers. He is also replacing a gas engine with a 200-h.p Westinghouse motor for the Delta Land Company. The Pacific Gas and Electric Company is running a branch power line into this district to furnish current for pumping.

INDUSTRIAL

ELECTRICAL FLORAL DECORATIONS.

Light is more nearly symbolical of the spirit of Christmas than any other physical manifestation. The electric light, in particular, is annually becoming a more important factor in the observance of this festival, not only on the Christmas tree, but on the table. For this purpose many beautiful designs are now available, a few being shown on this page.

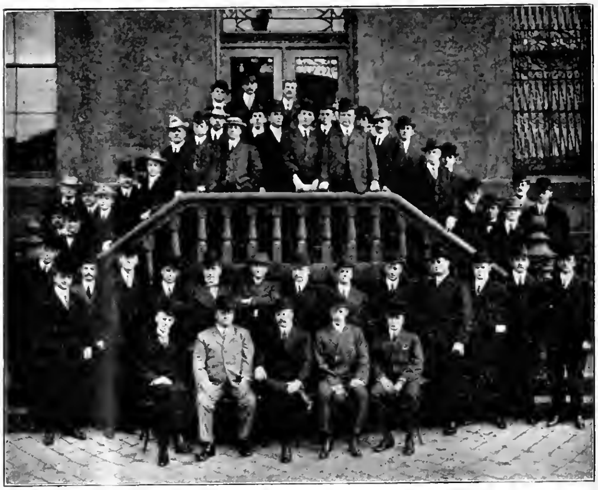
Large Rose Basket.

Electric Lighted Rose Vase.

These comprise a number which the Brooks-Follis Electric Company of San Francisco is prepared to furnish the dealer and central station in time for the annual holiday trade. They are the products of the highest artistic skill and are also electrically perfect, being fully approved for connection on the ordinary lighting circuits. They comprise vases and baskets of roses, chrysanthemums, tulips and poinsettas in all the colorings of nature, as well as the various table fruits. As such they make a most effective and beautiful decoration for the home electrical.

Hanging Baskets of Roses.

ELECTRIC STORAGE BATTERY CO. CONVENTION.



The Electric Storage Battery Co. of Philadelphia, held the sixth convention of its staff and sales department at the Bellevue-Stratford, Philadelphia, on November 6th, 7th, 8th, 9th and 10th. The convention was attended by the managers and salesmen from its various sales offices in Philadelphia, New York, Chicago, Boston, Cleveland, St. Louis, Denver, Detroit, Atlanta, and San Francisco. At the conclusion of the convention a company banquet was held at the Radnor Hunt Club.

WHY CALIFORNIA ISN'T ALARMED.

The Financial World of New York recently commented on California conditions as follows:

A leading bond and investment house which is interested largely in public utility enterprises in California, has received from its San Francisco correspondent a review of conditions in the State which perhaps goes far toward explaining why capital and bankers generally have been viewing with the greatest complaisance the recent victory of the radicals in the California elections. Woman suffrage, the recall, the initiative and referendum, a rate-regulating commission and many radical measures designed to restrict capital, were indorsed at that election, and most of these policies will be incorporated in the new State Constitution next year. Since the election there have been primary contests under the new laws and radicals have been named for office in several large cities. But capital has never been the least disturbed and at the present time there are, perhaps, in prospect in the chief State of the Golden West, more new enterprises than ever before undertaken.

The letter above referred to, written well after the elections and at a time when the full effect of the contests could be judged properly, says that as far as the banks in California cities are concerned the average city bank in California is at present carrying a larger account in bonds than any of the country banks in any other section of the country. One possible exception, the correspondent says, may be some of the old investment institutions in the Eastern States, in which the demand for money is very small. With the California banks well supplied with bonds, nevertheless the demand for investment securities is still very good, and this is probably due to the very heavy crops, such as barley, hops, fruits, etc., and for which the prices are the highest in a long period. The proof of the general prosperity is to be found in the fact that the bank deposits have practically doubled in the last three months. There is also general satisfaction at the continued good earnings of the great public utility companies throughout the State.

All this evidence of prosperity is, we think, proof that the alarm felt in many quarters over the advent of radical policies and extremists in politics is greatly overdone, and especially are the harmful effects less apparent when crops are good and prosperity reigns. The radicalism of today is little more than the expression of undue caution over the rapid increase in wealth the country over. Perhaps if we did not have this check as a sort of balauce wheel recklessness and expansion in finance and trade might go to alarming lengths.

RESTORATION OF TELEPHONE SERVICE IN 98 HOURS.

The Missouri and Kansas Telephone Company's Fairmount Exchange, at Kansas City, Missouri, was completely destroyed, on Sunday, October 22d at 3 a. m., by a fire which is believed to have been caused by an explosion of gas in the house adjoining that in which the central office was located. The telephone company at once communicated with the Western Electric Company and the work of restoring service to the subscribers was begun at 9 o'clock of the same morning, when a dozen men from the electric company's local installing force appeared upon the scene.

The Hawthorne factory of the Western Electric Company was called upon by long distance telephone to make a hurry-up shipment, and responded by sending forward the necessary apparatus by express the evening of the day on which the fire occurred, thus supplementing without delay the work which was being done by the local house in rushing material to the building in which the new exchange was to be housed.

The new switchboard equipment consisted of several sections from the telephone company's stock, and some from an addition which was to be installed at the Rosedale Exchange, on account of the increasing business in that district. Twenty-six installers reported for work on Monday morning, October 23, and from that time until the new board was cut in service at 5:00 a. m., October 26th, with a full equipment of 800 subscribers' lines, a day and night crew were at work continuously.

Taking into consideration the fact that the work was done under high speed conditions, in order that the subscribers might not be inconvenienced for an extended period, it is worthy of note that the trouble reports issued as a matter of routine by the telephone company indicate that the work of the Western Electric Company's installing force was so well done that a minimum of trouble was experienced after the new equipment was cut into service.

CALORIZED ELECTRIC SOLDERING IRON.

The use of the ordinary soldering iron has two serious drawbacks—the impossibility of keeping it hot continuously, and the rapid wasting away of the copper. The development of the electric soldering iron obviated the former, furnishing the mechanic with an iron which not only stayed uniformly hot all the time, but one in which the heat intensity could be easily regulated by the mere turning on or off of the current. The second fault, that is, the rapid wasting away of the copper, still remained, to a large extent, necessitating frequent renewals, and, consequently, making no reduction in the cost of maintenance.

Therefore, it is of much interest to metal workers to know that many experiments made in the research laboratories of the General Electric Company to mitigate this fault has resulted in the discovery of a process of treating the copper which renders the latter non-oxidizable under high heats and non-corrodable by the acids used in soldering. Furthermore, it reduces to a minimum the dissolving action of the molten tin, with which the working tip must always be kept coated.

This "calorizing" process or method of treatment does not merely coat the surface of the copper with a thin layer of non-oxidizable or non-corrodable substance, liable to scale off under the effects of heat and acids; but actually changes the characteristics of the copper to an appreciable depth. Thus the durability or practical working life of the copper is increased to such an extent as to provide a soldering iron of maximum economy and effectiveness.

CUTLER-HAMMER FEED-THROUGH SWITCH.

The Cutler-Hammer Feed-Through Switch provides a convenient means for controlling heating device circuits. Flat irons, toasters, disc stoves, chafing dishes, percolators, soldering and branding irons, etc. can be more economically operated if a convenient means be provided for turning on and off the current.

This switch is also of value in manufacturing plants. Portable drills, vacuum cleaner sets, electric hammers and other electric motor-driven and heating devices can be controlled by this feed-through switch. The devices mentioned are often operated at considerable distances from their sources of current supply and a ready means for opening and closing the circuit saves valuable time.

The feed-through switch provides a convenient means for breaking the circuit when the iron gets too hot or when the work being done is of such a nature as to require a cooler iron. To manipulate the key of the fixture socket frequently is inconvenient and also results in rapid destruction of the socket.

NEWS NOTES

INCORPORATIONS.

ASHLAND, ORE.—The Dead Indian Telephone Company, capital $2000, of this place, has been incorporated.

LOS ANGELES, CAL.—Empire Electric Company—capital $100,000; directors, E. J. Rose, S. J. Mathes, A. H. Honey, P. H. Tyler and F. J. Ryan.

LOS ANGELES, CAL.—Union Coal & Electric Company—Capital $1,000,000; directors, R. O. Young, G. C. Beaman, W. H. Packard, G. R. Williamson and I. C. Long.

LOS ANGELES, CAL.—Miller Storage Battery Company, incorporators George J. Miller, Frank J. Miller, Clarence H. Miller, Albert Burdett Hanson and Thomas L. Gifford, capital stock $10,000.

LOS ANGELES, CAL.—California Pipe Line Company—capital, $5,000,000; directors, R. L. Cox, J. Fred Gale, S. N. Clark, J. J. Doran, August P. F. Hartnack, Homer R. Crouse and J. H. Englehart.

LOS ANGELES, CAL.—Eureka Electric Manufacturing Company, incorporators, F. W. Post, F. B. Howard, James A. McGowan, Fred St. Clair and A. A. Cole; capital stock, $100,000; subscribed, $1.

SANTA ROSA, CAL.—California Telephone & Light Company, $10,000,000, by J. E. Bennett of Palo Alto, F. L. Wright of Santa Rosa, A. B. Spurr of Lakeport, M. S. Sayre of Lakeport, W. P. Ferguson and S. Pickering of Santa Rosa and H. L. Nay, Kellogg.

STAYTON, ORE.—The Santiam Light & Power Company has been incorporated for $25,000 by A. L. Shreve, S. L. Stewart and J. W. Mayo to take over the property and business of the Stayton Electric Light Company. A number of improvements and additions are to be made to the system.

SAN BERNARDINO, CAL.—The Citrus Belt Gas Company has been organized with capital stock of $1,500,000, to take over the plant of the San Bernardino Valley Gas Company. The directors are: A. M. Ham, E. D. Roberts and Z. T. Bell of this city, F. Morrison of Redlands and E. S. Moulton of Riverside. The company will not only supply gas, but electrical energy both for light and power purposes.

SACRAMENTO, CAL.—Articles of incorporation have been filed of the Sacramento & Eastern Railway. The road is to extend from Sacramento to Folsom and is incorporated for $1,000,000. The incorporators are Charles H. Hammon of Berkeley, L. J. de Sabla, San Francisco; Samuel Lillienthal, San Francisco; George E. Springer of Oakland and Herbert W. Furlong of Pleasanton. Twenty thousand dollars' worth of stock has been subscribed, Hammon having pledged for $18,000 of this and the other $500 each. The road will be approximately 60 miles in length, swinging southeast from Sacramento to a point midway between the capital city and Folsom and then northeast into Folsom, practically keeping in view of the Southern Pacific the entire distance.

PORTLAND, ORE.—The Deschutes Rimrock Power Company has been incorporated with a capital of $1,000,000, with Malcolm A. Moody as president and LeRoy Park, as secretary and treasurer. The company expects to start actual construction work within 90 days, as the entire bond issue of $9,000,000 has been approved and money will be available for work within that time. The project provides for a small dam 500 feet long and 20 feet high, which will be capable of developing a minimum of 15,000 horsepower and the other and more important dam will be a hollow concrete structure of the Ambursen type, 140 feet high and over 600 feet in length. This will develop a minimum of 60,000 horsepower and will be the greatest power dam in the Greater Northwest. The two dams will be 7000 feet apart, the smaller being placed just north of Moody, the first station south of the Columbia River on the Deschutes railroad. The land to be watered lies on the Columbia River and will include in its first unit 15,000 acres.

ILLUMINATION.

PASCO, WASH.—The City Council has ordered the street lighting committee to engage Engineer H. Day Hanford of Seattle to prepare plans for a municipal lighting plant.

HOOD RIVER, ORE.—On recommendation of the light and water commission the City Council has contracted with the hydroelectric company for the term of 10 years for lighting the city streets,

SAN DIEGO, CAL.—The City Council has decided to approve plans of Superintendent Adams to light the down town streets with ornamental cluster lights. All lights in down town district will be in by January 1.

BAKERSFIELD, CAL.—The City Clerk has been instructed to advertise for bids for lighting the streets of Bakersfield with luminous arcs, the number of lights to range from 175 to 250, and the lighting to be on the all-night basis.

WATSONVILLE, CAL.—This city is to have an improved system of street lights. The system recommended by S. W. Coleman, manager of the Coast Counties Light & Power Company, consists of 350 Mazda type arc lamps.

FALLON, NEV.—At the last meeting of the City Council the plans and estimates presented by City Engineer C. P. Osgood for an electric light system for the city were accepted and the city attorney was instructed to draft an ordinance providing for the issuance of bonds to the extent of $15,000 to install the proposed system.

SAN FRANCISCO, CAL.—The State Board of Control is preparing to contract for the purchase of all the electric light globes used in all of the State institutions by bulk. It is estimated that 25,000 electric bulbs are used in the State institutions each year, and by purchasing them in bulk a saving of approximately $5000 will be made.

BERKELEY, CAL.—Mayor J. Stitt Wilson has been asked by the City Council to procure data on the cost, charges and other information on municipal lighting plants which are now in operation throughout the country. The action of the council came after a proposal of the mayor, in a special message, that the city establish such a plant.

ALBANY, ORE.—W. H. McGoldrick has accepted the gas plant franchise granted him recently by the city. A forfeit of $1000 has been posted to guarantee the erection of the plant within a year. It is also asserted that McGoldrick is organizing a company to be known as the Albany Gas Company, to be incorporated with a capital of $500,000. A franchise was also received to install gas pipes along public highways in Linn county.

TULARE, CAL.—At a metting of the officers of the Tulare County Power Company a contract was awarded to Oscar Parlier for the brick and cement work on the auxiliary power plant to be erected in this city. There were several bidders,

but Mr. Parlier's bid was the lowest and most satisfactory. He will be required to lay about 200,000 bricks and build 7000 cubic feet of cement work. The contracts for the carpenter work will be let at an early date.

TRANSPORTATION.

PORTLAND, ORE.—The Southern Pacific Railway has entered into a contract with the Portland Railway, Light & Power Company for delivery of 5000 h.p. for the company's local Fourth street line. The railway will be electrified.

BAKERSFIELD, CAL.—The Board of Trustees passed an ordinance granting a franchise to the San Joaquin Light & Power Corporation, the right to construct and operate a street and interurban street railroad along, over and across certain streets, highways, etc., in the city of Bakersfield, Cal.

NAMPA, IDAHO.—Wm. Mainland and others have received a franchise of 50 years' duration for the construction of an electric street car system in this city. The franchise contains the usual paving clauses and other safeguards and provides that the franchise is void in case cars are not in operation by July, 1912.

CLE ELUM, WASH.—The Brown Company, Bailey building, Seattle, has been commissioned consulting engineers by the Kittitas Railway & Power Company to make preliminary and permanent surveys for its new hydroelectric development and electric railway from this city into the Cle Elum mining district, a distance of about 40 miles, at a cost of about $1,500,000.

VALLEJO, CAL.—The directors of the Vallejo & Northern Railroad voted to float $10,000,000 more in bonds. This money is to be used in construction and equipment. In order to simplify trade matters, T. T. C. Gregory has had the railway holdings turned over in his name. President Gregory appeared before the City Council and presented the map of the roadway through this city, and announced that as soon as it was accepted he would advertise for bids on grading. An ordinance extending the necessary permission for the road to use the city streets was ordered drawn up.

TRANSMISSION.

GOODING, IDAHO.—The substation of the Shoshone & Twin Falls Light & Power Company was burned a few days ago.

LEWISTON, IDAHO.—The proposition of installing a dam in the Clearwater River to provide a power plant for municipal and manufacturing purposes is receiving the consideration of the City Council.

STANFORD UNIVERSITY, CAL.—The construction of a new $14,000 powerhouse will be commenced at once between the history building and the football field. The plans were prepared by Prof. W. F. Durand. The building will furnish more shop room and experimental laboratories for the engineering department.

LEAVENWORTH, WASH.—A crew of engineers assembled at this point recently, taking final measurements and soundings on the river, preparatory to the construction of a concrete dam to be installed this winter for the Washington Steel & Iron Company. The company also proposes the establishment of a power plant to generate from 4000 to 6000 h.p. It is understood that plans are in course of preparation and at their completion bids on a general contract will be called for.

FRESNO, CAL.—Engineers of the contracting firm of Stone & Webster has arrived from Los Angeles in company with G. O. Newman, head engineer of the Pacific Light & Power corporation, and has gone with Mr. Newman and Manager A. G. Wishon of the San Joaquin Light & Power Company, to Big Creek, where a big power plant and dam are to be constructed. Preliminary work in this construction has been superintended by Mr. Newman, under the supervision of Mr. Wishon, and now the entire job of construction is to be turned over to Stone & Webster, under a newly formed contract.

RENO, NEV.—The Nevada Valleys Power Co. has been incorporated under the laws of Nevada, with Reno as the principal place of business and an authorized capital of $2,500,000. Messrs. J. E. Bowes, Hurley and M. S. Hamilton of Oakland are among the incorporators. Leon M. Hall, electrical engineer, is interested in the project and W. H. Leffingwell is the company's engineer. It is proposed to install two power plants in Storey County, Nevada, about 14 miles east of Reno with effective heads of about 90 and 75 feet, respectively. It is estimated that a total of 5500 h.p. can be generated and transmitted to Virginia City, Reno and elsewhere.

TELEPHONE AND TELEGRAPH.

MIDVALE, IDAHO.—The Midvale Telephone line has been sold to Levi Keithly and Roy Delashmutt. An entire new equipment is to be located in the McCrum building on Bridge street.

KLAMATH FALLS, ORE.—After keeping forty fires going night and day for weeks to heat concrete, and building large canvas walls and ceilings over the work to keep the heat in, the contractors of the Lost River diversion dam, building for the reclamation of 50,000 acres inundated by Tule Lake, have put in all the concrete without damage from frost. The dam is of the horseshoe type.

SUSANVILLE, CAL.—Application for a franchise for a period fo 50 years has been made by the Honey Lake Valley Mutual Telephone Association to the Board of Supervisors, for the right to erect, construct and operate a telephone and telegraph line over certain roads and highways in the county of Lassen. Bids will be received for the sale of said franchise up to January 4, 1912, at which time the franchise will be sold to the highest bidder.

WATERWORKS.

MEDFORD, ORE.—The citizens of Gold Hill have adopted a new charter and passed a bond issue of $25,000 which will be used to construct a modern water supply.

McMINNVILLE, ORE.—A. L. Richardson of the Portland engineering firm of Stannard & Richardson is preparing the plans for the installation of a water system at Carlton.

SEATTLE, WASH.—Prof. E. O. Eastwood, consulting engineer of the university, has completed plans for a 100,000 gallon steel water tank recently. Bids are to be called for immediately.

LOS ANGELES, CAL.—The Verdugo Springs Water Company has been awarded a contract for laying 5000 feet of four-inch steel water mains throughout the Kenilworth Tract, in Glendale. The Southern California Gas Company will supply gas for the tract.

RICHMOND, CAL.—The contracting agent of the Union Water Company of Oakland, Col. M. M. Ogden, has announced that his company, owned by the United Properties corporation will invade the Richmond territory at once in opposition to the Peoples company. The latter has up to this time held a monopoly of the field, with the exception of the private water company that serves the Santa Fe district.

ALPHABETICAL INDEX TO ADVERTISERS

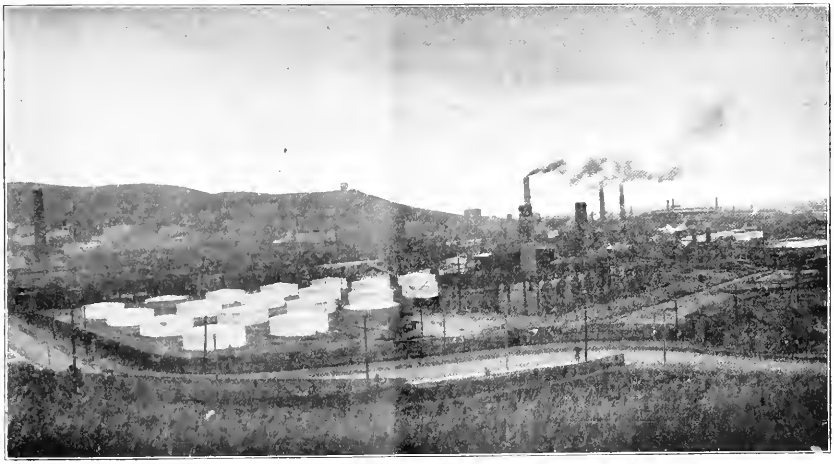
// JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXVII SAN FRANCISCO, DECEMBER 16, 1911 NUMBER 25

OIL BURNING

BY E. N. PERCY.

Many engineers and business men hear of oil burning, see records of oil burning tests with their excellent results, and read long academic discussions on oil burning without having learned in the least degree how to install an oil burning equipment on their own plant. The following article is addressed to engineers and business men in plain non-technical terms with a view to telling them how to get ready to burn oil and then how to burn it.



Oil Storage Tanks at Refinery

The first thing necessary with fuel oil is to receive it. The price must be learned, freight rate on the oil and any other necessary charges such as carting, switching, etc. Fuel oil is delivered exclusively in bulk, either in tank cars, barges or steamships. It should be an oil which has neither light volatile constituents nor extremely heavy constituents; neither should it be an oil which has been taken directly from the well without properly settling to eliminate water, gravel, and other debris. All oil has practically the same heating value; the differences being so small that they cannot be discerned except in the highest grade plants.

All fuel oils in general use ranging from 14 degrees Beaume to 25 degrees Beaume contain between 6,000,000 and 6,400,000 British thermal units per barrel, the total variation not being over 4 per cent, and that in favor of the heavier oil. Light oil has more heat per pound but less per barrel; heavy oil has less heat per pound but more per barrel on account of its weight. Therefore, heavy oil is the cheapest to use; but if too heavy will make so much carbon and smoke that there is an excessive waste.

To receive the oil it is necessary to put in storage. This may take the form of steel tanks above the ground, concrete vaults under the ground, or in small installations wooden tanks above the ground. Concrete vaults and forms may be roughly figured at 50 cents per cubic foot of concrete and the excavation according to locality and material, averaging 60 cents per cubic yard. Steel tanks including foundation, roof and setting up will cost approximately $1 a barrel.

The accompanying curves show the cost and weight of various kinds of tanks. These costs apply primarily around San Francisco Bay; for other districts freight rates, labor charges, etc., should be added accordingly. Fig. 2 shows the swing pipe and

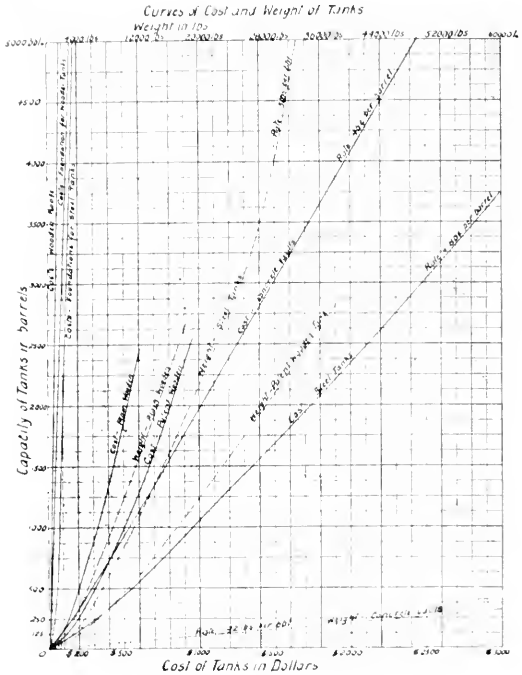


Fig. 1. Curves of Cost and Weight of Tanks.

heating coils that are used in large tanks for warming up the fuel oil.

It should be stated here that the burner is the last and almost the least important thing in an oil burning installation; the most important being ample means for heating the oil. This latter includes heaters in the main storage and a heater for bringing the oil to final temperature just before going to the burner.

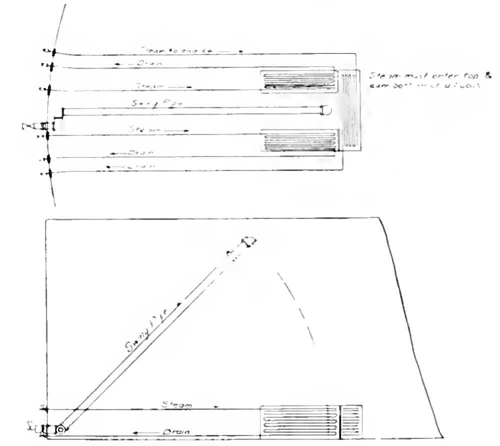


Fig. 2. Swing Pipe and Heater Coils for Tank.

By using the arrangement of heaters shown in Fig. 2 only the oil going into the suction pipe is heated, it not being necessary to heat the entire tank. This arrangement is intended for a very large installation; with a smaller installation a simpler arrangement will answer; but there should be at least one square foot of heating surface for every barrel in the tank.

Nearly always the heating coils which have been installed in a small tank will be found out of commission because of breakage or leakage. This is because they are entirely too small. The coils should be constructed of 2 in. pipe no matter how small the tank is. This is little if any more expensive than smaller pipe because the 2 in. pipe has relatively greater area.

The swing pipe is necessary only in large tanks when they are above ground to prevent the accidental draining of the entire tank in case of breakage of large pipes.

Fig. 3 shows the proper way of connecting large or small pipes through the tank shell; running threads with lock collars are not good engineering and should

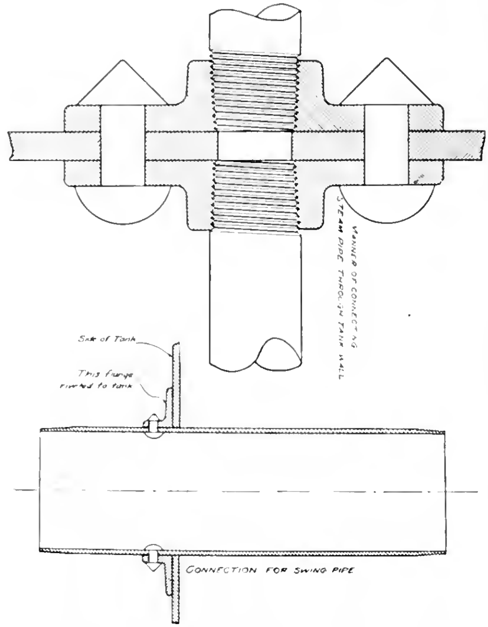


Fig. 3. Correct Methods of Running Pipe Through Tank Shell.

never be used. Concrete tanks should be reinforced and plastered on the inside with at least one inch of cement plaster. They will be a failure unless of the best construction. The underwriters and various cities have requirements in connection with the storing of oil which must be met in order to carry insurance and observe the law, to say nothing of the actual safety obtained. The first principle in this respect is that no gravity system is permissible. The oil must be stored below the level of the burners and reach same by means of pumps only.

Fig. 4, 5, 6 and 7 show various phases of permissible installations under the ordinance in San Francisco.

Having investigated the cost of delivering oil and prepared proper storage for it in accordance with the

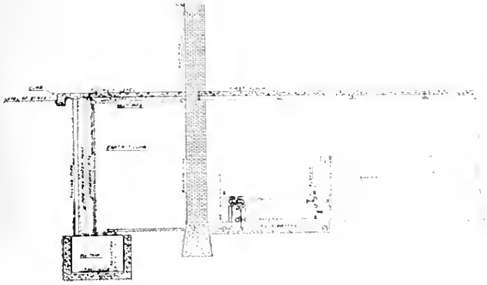


Fig. 4. Oil Tank Below Basement Floor Level, Boiler in Basement (sidewalk not excavated).

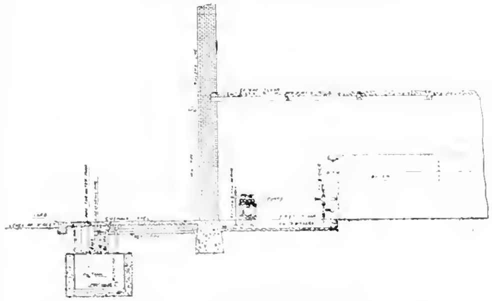


Fig. 5. Oil Tank 4 Feet Below Sidewalk, Boiler on Ground Floor (no basement).

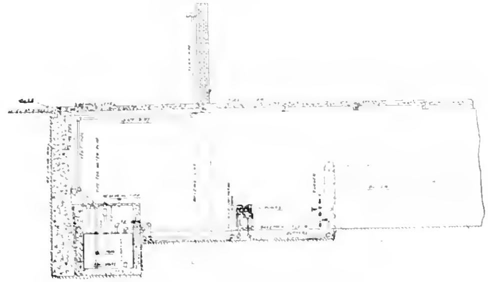


Fig. 6. Oil Tank and Boiler on Basement Floor (sidewalk excavated)

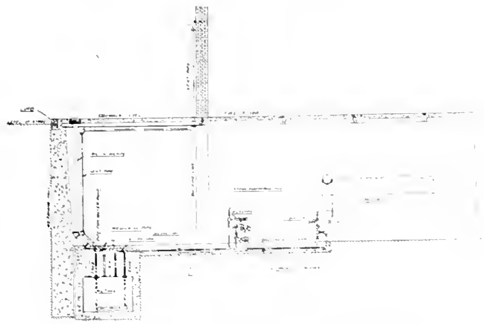


Fig. 7. Oil Tank 4 Feet Below Boiler Room Floor, Boiler in Basement (sidewalk excavated).

rules of insurance, laws of communities, and proper construction, we are now ready to pump it to the power plant. Ordinary duplex pumps installed in duplicate probably give the best satisfaction, although rotary pumps, belt-driven triplex and other types are used for the purpose. It is advisable to install oil pumps in duplicate because one of them will frequently be deranged because of gravel in the oil or valves hung open with asphalt, or gases formed from oil that has too many light fractions. It is not advisable to install a pump smaller than 4½ x 3 x 4 for any purpose whatever.

Arrangements are usually made for the oil to be delivered at a constant pressure. This is done either by means of one of the various patent governors on the market, or by means of an ordinary pop valve discharging into the pump suction. Many plants are running without any regulating device whatever.

Probably the best system is one in which the oil pressure is regulated by the steam pressure whereby the boiler automatically regulates its own fire; but this does not imply that an oil fire should be left without attention. It requires very little work and the fireman has plenty of time to do many other things, but his bench or other work should be in the fire room

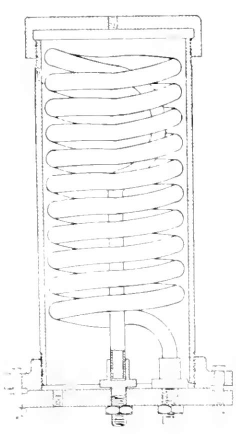


Fig. 9 Single Coil Oil Heater

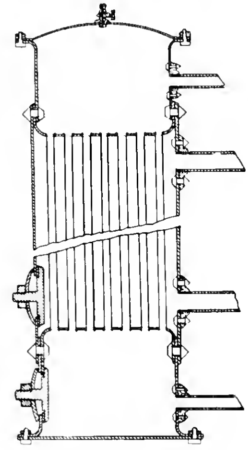


Fig. 10. Multitubular Oil Heater

and not elsewhere as oil must not be left without attention under any circumstances, no more than coal. After the oil leaves the pump it goes direct to the heater, a device in which it is brought to the highest temperature possible with live steam, not exhaust or waste steam.

Fig. 9 shows a simple type of such a heater which can be constructed by any engineer. It is not very ornamental but does the work. The oil is within the pipe and the steam around it. Fig 10 shows a multitublar heater. Fig. 11 is a double chest heater, the design of which is obvious.

Fig. 12 is probably the best and most expensive heater that can be built for large heavy work, consisting of a copper coil supported on a steel rack within a steel boiler shell bolted to a cast iron base thoroughly lagged with a non-conductor and finished off with sheet iron.

Fig. 13 shows the arrangement of steam piping in an oil burning plant. Fig. 14 shows oil piping in an oil burning plant arranged in what is called a non-

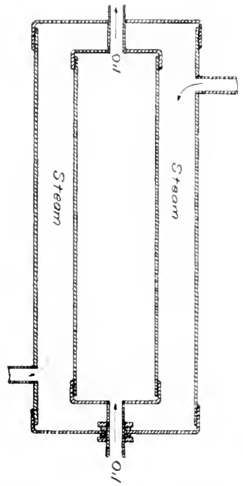


Fig. 11. Cast Iron Oil Heater

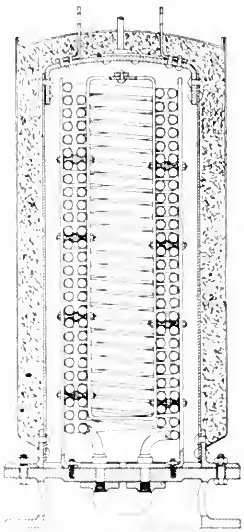


Fig. 12. High Duty Single Coil Type of Oil Heater.

return system; the oil simply flowing from the pump through the heater to the burners. Fig. 15 shows the oil piping arrangement in what is called a circulating oil burning system. In this case the oil flows

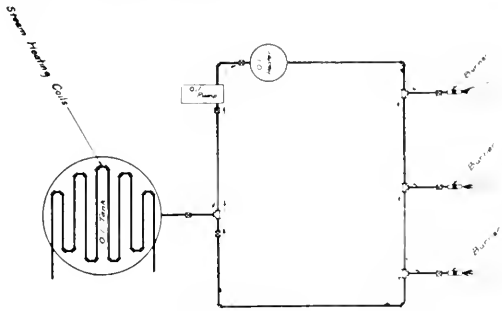


Fig. 13. Steam Piping Arrangement in Oil Burning System.

from the pump through the heater to the burners, giving them what oil they need and then flowing back to the pump suction. This is necessary in every large

Fig. 16 shows in a measure, the entire piping arrangement of an oil burning system. The oil stand-

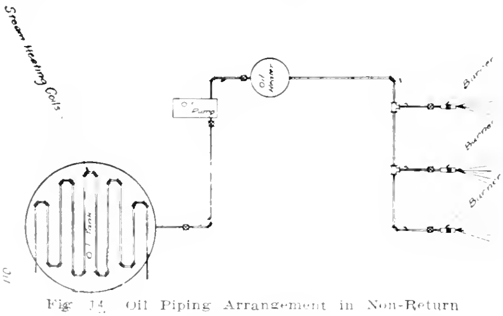


Fig. 14. Oil Piping Arrangement in Non-Return Oil Burning System.

plant or in very long lines in order to keep the oil hot, especially when the fires are low.

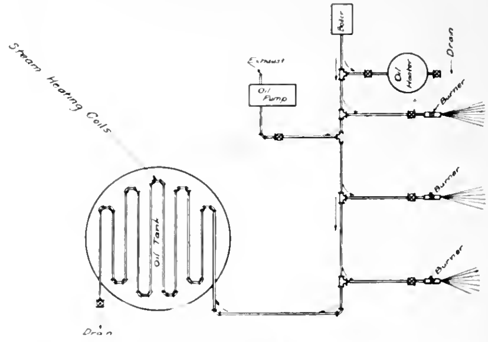


Fig. 15. Oil Piping Arrangement in Continuous Return System.

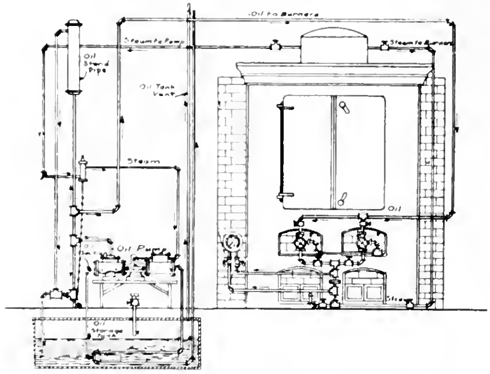


Fig. 16. Piping Arrangement for Atomization by Steam.

pipe is for the purpose of trapping gases, etc., that may be in the oil, and must be blown from time to time.

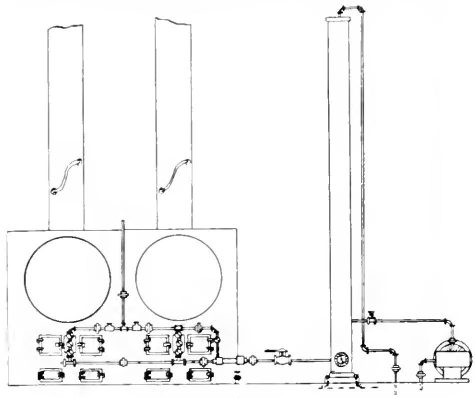


Fig. 17. Piping Arrangement for Atomization by Compressed Air.

Fig. 17 shows an oil burning system in which provision is made for atomization by compressed air.

In the most recent practice the oil and steam are not regulated within the burner but by outside valves.

The best practice calls for a burner of the utmost simplicity with regulating valves just outside of it. Ordinary globe and needle valves do not regulate well for many reasons, a valve of the type shown in Fig. 18 being much more desirable because regulation is effected by the uncovering of the diamond-shape port by the piston, but when the valve is brought to full closure it seats as any ordinary globe valve. The strainer is simply to prevent sediment from getting into the valve or burner and can be removed at a moment's notice for cleaning.

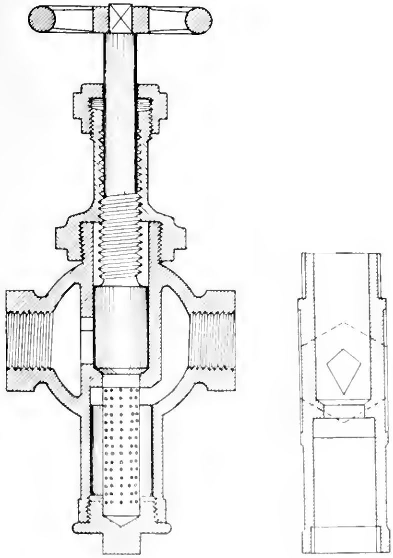


Fig. 18.

Furnaces.

The arrangement of boiler, furnace, chimney, draft, brick work, front, and dampers is far more important than the burner, although the type of burner should accord with them and produce the shape of flame desired. Various errors still exist in oil burning as hold-overs from coal furnaces. One of these is the existence of the bridge wall. There absolutely should be no bridge wall in connection with an oil fire except in those types of water tube boilers where the bridge wall extends up to the tubes.

Fig. 19 shows an internal fired boiler that was specially designed for oil firing by making it extremely long. This method of bricking has proven very satisfactory with the exception that the bridge wall tends to throw the flame against the crown sheets, which, of course, is bad practice.

Fig. 20 shows a return tubular boiler of the ordinary type properly bricked up for oil firing, the principal features of which are that the flame has a complete unbroken sweep from one end of the boiler to the other; no air is admitted overhead, and all air must pass through the flame, it being admitted through an evenly distributed grill below a flat flame. The protection provided for the blow pipe should be noted.

Fig. 21 to 24 shows incorrectly fired boilers. Many boilers have been fired in each of these ways and have given fair service, but experience has proven that they have the following faults respectively:

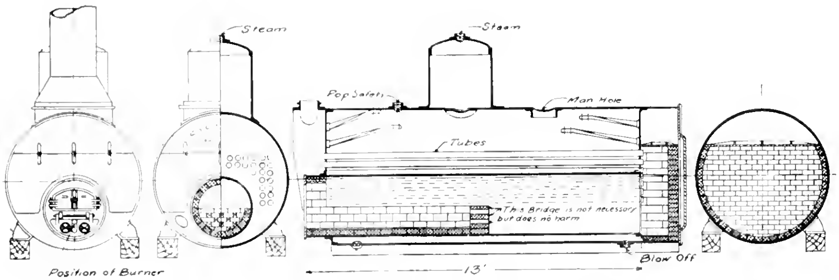


Fig. 19. Arrangement of Internally Fired Boiler Specially Designed for Oil Burning.

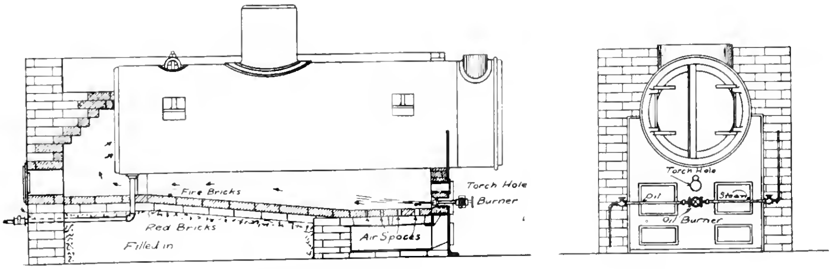


Fig. 20. Arrangement of Return Tubular Boiler for Oil Burning.

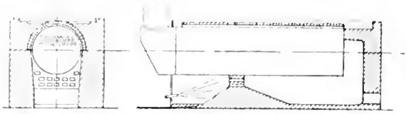


Fig. 21. Return Tubular Boiler (Bridge Wall Target)

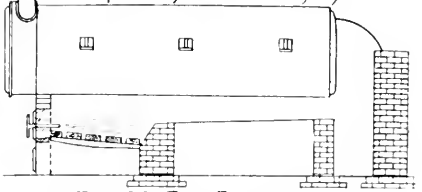


Fig. 22. R. T. Bridge Wall

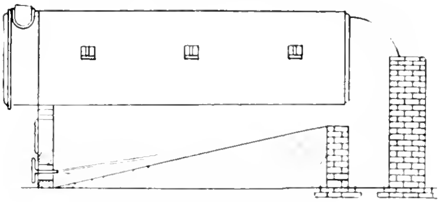


Fig. 23. R. T. Sloped

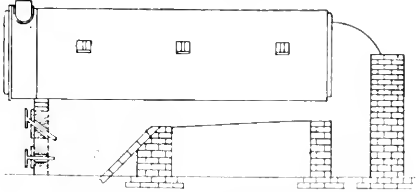


Fig. 24. Return Tubular Boiler (Frontshot Target)

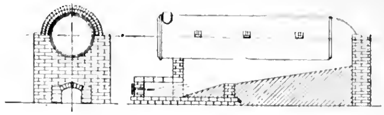


Fig. 25. Return Tubular Boiler. Front Tunnel (Forward shot.)

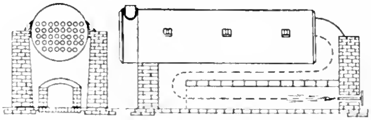


Fig. 26. Return Tubular Boiler (Backshot Tunnel)

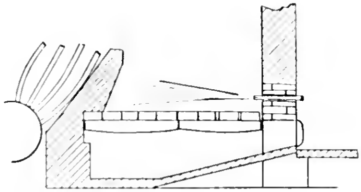
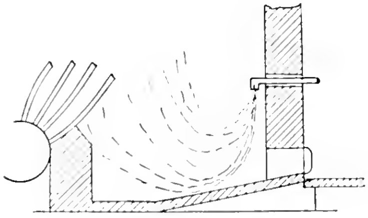


Fig. 27. Stirling Boiler (Frontshot)



(Downshot)

Fig. 21 will tend to burn the boiler around the bridge wall and the flame tends to smoke and deposit carbon.

Fig. 22 admits a great amount of excess air because all of the air does not go through the flame; therefore, this boiler can never be very economical.

Fig. 23 will tend to throw the flame up against the boiler, over-heating that portion.

Fig. 24 has all of the objections mentioned; in fact the practice of burning oil with a target has been entirely abandoned by progressive practical engineers.

Fig. 25 and 26 give fair satisfaction under heavy load because the tunnel is full of flame, is quite hot, and all the air has practically passed through the flame; but under light loads they are not so efficient, and, furthermore, it has been found almost impossible to maintain arches over the tunnels at the high temperatures resulting.

Fig. 27 shows two methods of firing a Stirling water tube boiler. The system shown in the upper picture savors of the target method of firing, and perhaps is not as desirable as the system shown in the lower sketch for extremely heavy firing.

Fig. 28 and 29 show usual methods of firing a Heine boiler. Fig. 28 being the incorrect arrangement, and Fig. 29 being the correct arrangement.

Fig. 31, 32 and 33 show various methods of firing Babcock-Wilcox boilers. There are probably no serious arguments against any of the three methods, but Fig. 31 is the usual installation in the largest plants.

(To Be Continued)

COST OF ELECTRIC OIL PUMPING.

A statement has been prepared by the Petroleum Properties in which is compared the cost of steam versus electric power for development on the property on sections 22 and 23, in 32-33, Midway. Cost of installation and equipment $10,710, loss from discard $1000, total cost to be absorbed $11,710. Assuming life of installation to be ten years, the amount to be written off each year is $1171. The average cost of operation per month by steam was $2753.07, by electricity $1903.07; saving $850; less $97.58 amount to be written off per month, $752.42. On this basis the plant will pay for installation in 15½ months. As yet two wells and the shipping plant are operated by steam thus raising the cost of fuel and water.

The cost of steam pumping for five months, from January 1 to May 31, showing only accounts affected by electrical installation, was 10.67 cents per barrel; from July 1 to September 30, three months, the cost per barrel was 5.86 cents, a saving of 4.81 cents per barrel.

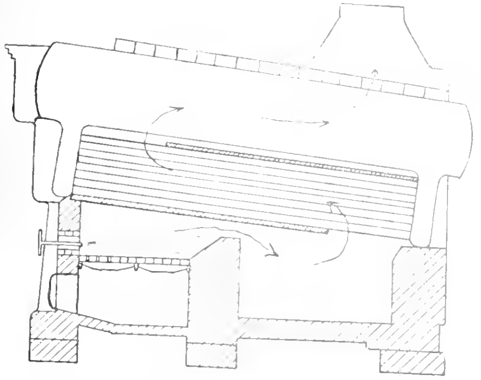


Fig. 28 Heine Boiler (Forwardshot.)

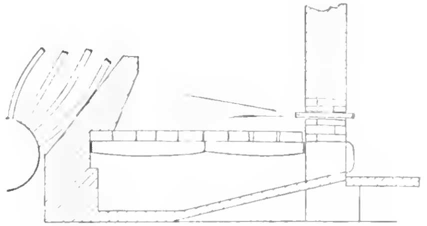


Fig. 29. Heine Boiler (Correct Firing)

Fig. 31 B.&W. Boiler (Backshot)

Fig. 32. B.&W. Boiler (Downshot)

Fig. 33 B.&W. Boiler (Backshot)

CRUDE PETROLEUM PRODUCTION.

More than 200,000,000 barrels of oil, with a value of nearly $128,000,000, [illegible] in the United States last year, according to David T. Day, of the United States geological survey, [illegible] chapter on petroleum [illegible] "Mineral Resources [illegible] United States" for 1910.

The petroleum [illegible] States, says Dr. Day, has been characterized [illegible] increase each year for the [illegible] year's gain over that of the [illegible] remarkable as to lead to the [illegible] limit of production had been reached, [illegible] increase has continued rapidly. After [illegible] 50,000,000 and 60,000,000 barrels annually [illegible] decade between 1890 and 1900, the oil output [illegible] 63,000,000 barrels in 1900 and increased [illegible] barrels in 1902. In 1903 it passed the 100,000,000 barrel mark, in 1904 it was over 170,000,000 barrels, [illegible] in 1905 [illegible] 135,000,000 barrels. After a slight decline in [illegible] output rose again, in 1907 reaching 166,000,000 [illegible]. It was 178,000,000 barrels in 1908, 183,000,000 [illegible] in 1909, and 209,556,048 barrels in 1910, a gain of [illegible] per cent over the record output of 1909. This brought the total output since the beginning of the petroleum industry to more than two billion barrels.

The United States is now by far the greatest oil-producing country; in fact, it produces more than all the rest of the world together. In 1910 the wells of this country yielded nearly 64 per cent of the total production, Russia scoring a very poor second with about 70,000,000 barrels, or 21 per cent. The production of other countries is comparatively negligible, the third on the list, Galicia, contributing only 3.87 per cent of the total.

The excess of the petroleum production of the United States over the normal demand is shown by the fact that the 209,556,048 barrels produced in 1910 brought a smaller return—$127,896,328—than the 183,170,874 barrels in 1909, which was valued at $128,328,427. The even smaller output in 1908, 178,000,000 barrels, was valued at still more—$129,079,184. As the production has increased the average price has gone down from more than $1 a barrel in 1900 to 61 cents in 1910.

These repeated great increases in oil production have been due to the successive development of four great petroleum fields farther west than the old productive centers. By 1900 the country had adapted itself to the flux of oil from western Ohio and Indiana; then came in rapid succession the development of the Gulf field in Texas and Louisiana, the Mid-Continent field in Oklahoma and Kansas, and the Illinois field. In the meantime California's production had been increasing so rapidly that it became the dominant feature of 1909 and 1910, outstripping the production of

any other State and promising to retain this supremacy in the future. The trade effect of these developments was largely discounted by the small proportion of gasoline and kerosene yielded by the Gulf and California oils and it was only when the superior character of the Mid-Continent oil was recognized that the middle western contributions began to be taken seriously in the general trade. Geographic and technical factors put California petroleum at a disadvantage compared with the eastern supply, but the great production has compelled such advances in refining methods as to make it reasonably certain that California will in the future yield good refined products, including lubricating and illuminating oils.

There are now 148,440 oil wells in operation in the United States. They average about four barrels a day, but in Pennsylvania and New York old wells in some districts yield a profit on an output of less than one-fifth of a barrel a day. The original Drake well, drilled in 1859, would probably, if it were cleaned, be capable of yielding one-third of a barrel a day. Another well close to the Drake well is 45 years old and is still being pumped.

Over 8,500,000 acres of land are leased for oil and 700,000 acres are owned in fee by oil operators.

The use of fuel oils is steadily increasing. Railroads consumed 24,586,108 barrels in 1910, against 19,939,394 barrels in 1909. The advantages of oil over coal have been clearly recognized by the United States navy. In new construction fuel-oil burners are being more and more extensively used; torpedo boat destroyers Nos. 20 to 50 burn oil exclusively and the battleships Delaware, North Dakota, Colorado, Utah, Wyoming, Arkansas, Texas, and New York burn oil as an auxiliary to coal. Battleships Nos. 36 and 37, authorized by the last congress, will burn oil exclusively, and it is probable that subsequent battleships will be oil burners. Dr. Day believes it to be probable that within a few years heavy oil engines of the Diesel type will be extensively adopted for marine propulsion, particularly for naval vessels, owing to recent improvements of these engines in Europe by which 1000 to 2000 horsepower can be developed from a single cylinder.

California heads the list of producers in 1910, with 73,010,560 barrels of oil, an increase of 17,538,959 barrels over the production in 1909. This output is more than twice as great as that of Pennsylvania for any year, and is greater than that of any foreign country; in fact, the production of petroleum in California and Oklahoma combined is practically equal to the entire foreign production. The average price per barrel of California oil in 1910 was 49 cents, the total value being $35,749,473. The 1909 price was 55.4 cents. The increased use of fuel oil in 1910 over 1909—more than 23 per cent—was due largely to California's energy in pushing the sales to the northwestern railroads.

The second among the oil-producing States in 1910 was Oklahoma, with a production of 52,028,718 barrels, valued at $19,922,660, a healthy increase from 1909 in both production and value.

The use of fuel oil increased in 1910 more than 23 per cent over 1909, which was largely due, says Dr. Day to California's energetic pushing of sales to the railroads in the northwest.

SOME SUGGESTIONS TO PREVENT ELECTRICAL ACCIDENTS IN MINES.

Suggestions for Mine Foremen.

Don't allow the men to ride electric locomotives.

Don't allow inexperienced men to handle electric wires.

Don't fail to protect the trolley wires at cross-overs and partings.

Don't allow wires to be installed in a slipshod manner.

Don't fail to have wires promptly repaired after roof falls.

Don't allow explosives to be carried in cars near the locomotive.

Suggestions for Electricians.

Don't fail to set a good example for less experienced men to follow.

Don't work on live apparatus if it is possible to cut off the current.

Don't stand directly on the ground and work upon live apparatus of any kind—get something dry to stand on.

Don't rely upon gloves for protection, unless they are perfectly dry, free from holes, and without metal parts.

Don't, under any circumstances, work on live apparatus that is charged with a voltage greater than 650 volts.

Don't handle wires carelessly just because they are insulated.

Don't send an inexperienced man to work on or about live apparatus.

Don't neglect to inspect your equipment regularly.

Don't ever cause anyone to receive an electric shock.

Suggestions for Miners.

Don't think that it is smart to get an electric shock. Every time a man gets a shock it shows that he has been lacking in care or knowledge.

Don't be ashamed to be careful. You owe this not only to yourself but to others who may follow your example.

Don't handle wires or electrical apparatus of any kind unless you are told to do so.

Don't get off or on trips from the trolley-wire side.

Don't carry tools on your shoulders when crossing under the trolley wire or when traveling in the same entry with it.

Don't travel in the same entry with the trolley wire if you can avoid doing so.

Don't get your explosives near electric wires.

Don't allow packages of explosives to come in contact with the metal parts of cars.

Don't carry explosives in cars near the locomotive.

Don't ever cause anyone to receive an electric shock.

Don't ride on electric locomotives.

Don't fail to report when you find that electric wires are down.

Don't install temporary lights—leave that work to the electrician.

PUBLIC CONTROL OF PUBLIC UTILITIES[1].

BY GEO. A. DAMON.

I am often asked where the movement for the public control of public utilities started and where it is going to end. There is no question about its having been started. The people a few years ago found out that they had a right to control—they were a long time in finding it out—but there is no question about their right to control. I have heard it stated that the State has a right to everything, to your property and to my property if it is necessary for the good of the State. It even has a right to your life, for if necessary you can be drafted into the army. But the State has no right to take your life or your property without compensation, and in exercising this right of public control we still have a great deal to learn. My formula for where it is going is this: that first it is to be public control; then it is to be public partnership, and then finally it is to be public ownership, but not necessarily public operation. Let me give you some of the reasons for this belief. Public control, of which we know all too little at the present time, and which is not exercised at all in a scientific manner, especially in this State, as yet, must, to my mind rest fundamentally upon the following fundamental requirements.

First: that it should secure adequate service. Now note, I do not put the regulation of rates first. To the popular mind public control means the regulation of rates, and the regulation of rates downward. I believe in the regulation of rates and I believe in the regulation of rates downward. It is the natural tendency and we should work for it. It is the thing the engineers of this country are going to bring about, but it is not the first essential, it is the very last one. Public control should mean first, the securing of adequate service. We need better street car service, better light service, better telephone service. There is no public utility that is adequate. So the first essential of public control is a technical problem of how to secure adequate service.

The second fundamental in my mind is to protect the investment. There has been a great deal of money invested in these public utilities. There has been a great deal of time and energy put in them; we cannot confiscate that investment—that time, ability and energy; it must be rewarded and it must be rewarded at a rate something larger than simply interest rates. To determine the amount of the investment involves all of the problems of appraisal and valuation, and of depreciation, and the question of what a fair return is upon a fair investment. These are all technical problems.

The third essential fundamental to my mind is to provide some definite form of renewal account. If our service is to be adequate; if our investment is to be protected we must have some automatic system for keeping the plant up to date and up to its highest efficiency, so we must study the question of depreciation and the requirements of the renewal fund.

The fourth fundamental is the question of betterments and extensions. Some people seem to have the idea that a public utility becomes finished; that after a certain investment is made, that is all there is to it. even the bonding people begin to retire their bonds after a certain amount of development. Now take the question of transportation; there is no end to it. It is a utility that calls, as all other utilities do, for a constant source of new capital; the system must constantly be extended. From my study of the transportation systems of the entire country I found this to be true; that the earnings increase as the square of the population; that means that when the population doubles, the riding habit doubles, and if the income per capita doubles and the population doubles, the total gross income increases four times. Now every dollar of increased annual earnings in transportation means a demand for about four dollars additional investment. Take it in Los Angeles; the local railways are earning about five million dollars a year. By the time that Los Angeles doubles its population inside of the present city limits the local transportation system,—if the increase is in the same proportion as the other cities of the United States, and I believe it will be more,—will be taking in twenty million dollars a year and this increase of fifteen million dollars in annual earnings will justify an additional investment of fifty to sixty million dollars. Now we cannot get this supply of capital at reasonable rates unless the present investment is protected. So that the fourth essential requirement that the technical man must work out is some arrangement for the future which will insure an almost unlimited supply of money for improvements and extensions.

The next fundamental I shall touch upon is very seldom spoken of,—and that is the requirement to amortize part of the investment. We recognize in making appraisals that there is something more than the physical value or the cost to produce the plant; we recognize what we are pleased to term development expenses,—some people call them "intangible values." They consist for instance of the discounts on the securities, of the profits of promotion; of the cost of consolidation,—because it costs money to get together the several systems that go to make a complete public utility; they include, perhaps, a few engineering mistakes in the past that are almost unavoidable in the developing of the property, and of a number of superseded investments that do not show upon the surface. All of these development expenses may amount to all the way from twenty to fifty per cent of the cost of reproducing the plant new, but because they are "intangible" and because you cannot see them, it would be better if the capital represented by these development expenses is wiped out. So I maintain that out of the first real earnings of the plant money should be taken to retire the investment in those development, intangible values, and there should be a fund created for that purpose. This is a point that is very often overlooked.

The next essential is to eliminate competition. We at one time thought the proper method of regulating public utilities was by means of competition, and if we had a telephone company that was not giving us good service we gave a franchise to another telephone company and sought to regulate the service and rates in that way; or in the case of a lighting company that did not reduce its rates we gave another

[1]Excerpt from address before Los Angeles Section, A. I. E. E.

franchise to a hostile system. Well, what was the result? We at once had a duplicate investment; two dollars doing what only one dollar should; a duplicate management and comparative inefficiency all the way down the line. The competition certainly reduced the rates temporarily, but neither company could give thoroughly adequate service, and I think we have come to the point where we have learned that competition is not the answer. So that one of the essentials of the future development of public utilities is to eliminate competition.

Public utility service as a rule is a natural monopoly; it should be encouraged as a monopoly, but as a regulated monopoly and as a protected monopoly, but still a monopoly. But if we encourage this monopoly how are we going to most effectively control it? Fix the rates so that they are sufficient to take care of these fundamentals that I have mentioned. Make the rates high enough or refuse to reduce them until such time that the income will take care of these fundamental essentials; until we have a depreciation fund to take care of our renewals; until we can be sure that we can take care of our maintenance and operating expenses; until we can pay a proper return on the investment; until we have money in the surplus fund to amortize some of the capital, and then let us retire some of it. There should be a surplus fund created with every public utility, but that surplus fund should not belong to the company. To my mind there is where scientific regulation can do its best work. Let the control of this fund be put in the hands of a technical commission which understand the business, and what will be the result? If it wishes to renew some of the property or replace some inefficient part with something that is more efficient so as to cut down the cost of operation, this fund will be sufficient for that purpose. If it wishes to extend the system into parts of the city where for a time there will be a non-paying load, that fund is available for that purpose. If it wishes to amortize some of the capital so that the fixed charges will be reduced part of the fund can be used in that way. A surplus fund of this kind would give a stability to the whole enterprise. Finally, when the fund gets sufficient to do all these things, then is the time to reduce the rates and the reduction of the rates will naturally follow, because both the fixed charges and operating expenses have been lowered. While the whole program tends towards the reduction of the rates it does not put the reduction of rates as the first essential.

If the surplus fund of the public utility corporations is thus controlled and at the same time the investment is made stable by insuring a return on the actual value of the property, then by this very arrangement the public enter into a partnership with the utility company.

Now this is not an idle theory, for it has been worked out in actual practice. We have practically this same arrangement in the Chicago traction situation. In working out the transportation problem there, a contract ordinance was entered into between all of the railway companies and the city in which the railway companies were practically operated as a protected monopoly. The companies were allowed five per cent return on their actual investment and the surplus fund was then divided; fifty-five per cent to the city and forty-five per cent to the company. The company was required by ordinance to maintain its property and have a sufficient renewal fund; and in making the arrangement the intangible values were given a certain value, and incidentally a great many of them were amortized at that time. Today the City of Chicago and the railway companies are in partnership, and the City of Chicago takes fifty-five per cent of the net earnings and is accumulating a fund which is available to either build sub-ways, to extend the service into non-paying districts; to reduce the fare if they wish to, or to buy out the company. So public partnership may actually end in public ownership; because after the public has learned the business and has treated the men who taught it the business right, it may finally say to Mr. Public Utility Man, and particularly to the promoter and the capitalist,—"Now don't you think you would like to take your money out of this enterprise and go into the flying machine business where there is a possibility of your making more money, and let us run this thing on a five per cent basis?"

But I want to warn you that there is a danger which every operator of every utility realizes today. The trusted employee will say, "What is going to become of me?" I don't want to work for the public; I don't want to play politics to keep my job." And to my mind if this evolution does end in public ownership and operation of these utilities there will be danger. I see only one way of overcoming it, and that is after we get public ownership then eliminate public operation and turn over the operation of these utilities to strictly operating companies organized without any necessity of raising capital or of financing, or of getting franchises, or of going into politics.

The State of California has voted to extend the duties of its State Railroad Commission so that it would have the powers of regulation over all of the public utilities in this State. The Railway Commission of Wisconsin have similar powers and its work commands the highest respect. Why? The Wisconsin Commission turned over its technical problems to an engineering organization which is controlled by the professors of the State University. From the first it built up a fabric of decisions based often upon the reports of its engineers. The result is that, in the State of Wisconsin the public utility business is in a state of balance.

California has an equal opportunity. Whether we are to have a State Commission which will be wise enough to bring about this result I don't know, but they have this Wisconsin precedent before them for their guidance. Personally I should be glad to see them take as their technical assistants the professors and technical organization of our State University. I should be glad to see that State Commission so efficient in its work, so careful in its judgment and thus commanding the confidence of every citizen that even Los Angeles itself would feel impelled to turn over its problems of regulation to a State Commission which would be entirely free from any local political influence.

DISCUSSION.

To the Editor: Your editorial, entitled "A Reply to Richard R. Crane," has been read with much interest. It was just to the point, and I am glad you found time to put down a word in protest to the views expressed in that publication, which, if not written by a great man, would be considered ridiculous by most people, and no attention paid to it.

When Mr. Crane talks about the Universities, he is evidently thinking more of business colleges and at the same time he has his own business too much in mind to be general. If he had said in his paper, that he in his business had no use for technical school graduates no one could have criticised him, as the articles in which he specializes certainly do not require technical skill to any greater extent than the manufacture of wheelbarrows on a large scale.

Mr. Crane seems to kick the electrical engineer the hardest. He seems to think, among other things, that the General Electric Company and the other big electrical concerns are frauding the young graduates, when they keep them in their testing rooms for two years at a small pay. This is, however, just the place, where they are constantly surrounded by an electrical atmosphere as Mr. Crane recommends himself, and where they have a chance to absorb in two years what it has taken the great men a lifetime to develop. Very few men are great enough to educate themselves, so the majority would either have to do without an education or go to "the technical school." But even the few who were able to educate themselves would surely go to the technical school if they had the opportunity—to save time, if for no other reason. It happens frequently that the "school teacher" is one of the best engineers in the country, who used to be connected with some of the largest and finest manufacturing establishments in existence before he took up teaching in the technical school. This fact at once excludes the possibility that his knowledge and what he has to say to the students should be merely humbug theory.

The method Mr. Crane suggests for the making of an engineer would perhaps do in the plumbing business, but in very few other lines of business would it produce a successful engineer.

Lars Jorgensen.

CHELAN DAM SITE UNSATISFACTORY.

The site selected by the Great Northern's engineers as preferable for the big dam to be built in the Chelan River gorge to develop the water power of Lake Chelan and the Chelan River, will probably be abandoned if any other reasonable good site can be found. Extensive prospecting discloses the fact that the bed rock is badly broken up and displaced. A thorough examination of the walls is now being made for another location farther up the canyon. If a better foundation cannot be found elsewhere the dam will probably be located on the site originally selected, but in that case deep and expensive excavations will have to be made.

HIGH TENSION DIRECT CURRENT TRANSMISSION.

Discussion by members San Francisco Section, American Institute of Electrical Engineers, October 27, 1911, of paper by C. F. Elwell, as published in this journal, Nov. 18, 1911:

S. J. Lisberger: Mr. Elwell has presented some interesting facts on this question. One thing he has omitted to mention, that is, the relative floor space required for the two systems, the a.c. versus the d.c. Have you any comparative figures on that?

C. F. Elwell: No, I have not worked that out. The most noticeable thing in entering the station is that you see nothing but machines. The switchboard is stuck away in a corner. You can figure on the space for your machines, and then add a 4 foot panel for the switchboard. I think the direct current system would compare very favorably on the question of floor space.

W. F. Lamme: Would this system replace what we have here on the Coast?

C. F. Elwell: This direct current is not a cure-all, but there are certain cases to which it applies. For instance you could have a number of stations scattered through the country and if they could be arranged in a ring, you could put up a pole line which, not having any cross-arms on it and one insulator and a fairly heavy cable, would be less expensive than ordinary pole lines. They do not attempt to distribute by direct current. They transform it back to alternating current for distribution.

W. F. Lamme: What kind of coupling do they have?

C. F. Elwell: The coupling is known as a Rafford coupling, and is made by having two discs each with a series of pins and leather belting between the pins, which take up the shock in starting, and also give sufficient insulation between the machines for the whole potential.

W. F. Lamme: Is that able to take care of 25,000 volts?

C. F. Elwell: Yes. They made tests on couplings with a space of eight inches for 100,000 volts.

S. J. Lisberger: Are the generators and motors shunt wound?

C. F. Elwell: No, they are all series.

S. J. Lisberger: What happens when they lose the load?

C. F. Elwell: If the line opens, and one end touches the ground, that eliminates some of the load. The machines will keep 150 amperes on the line in spite of anything. They will back voltage if it is a dead short near the station, until they only generate a few volts.

S. J. Lisberger: I don't know that I would agree that that is a great advantage. How do they take care of sudden changes of load at this plant?

C. F. Elwell: They will take care of themselves automatically. There are few sudden changes possible. Suppose a cement mill were about to shut down. They back off the brushes; that is one gradually, reducing the voltage. Finally when they are down almost to zero volts they close the short circuit switch, and there isn't any great change of load.

Question: Suppose you have a motor in series with a generator- alternating current generator; suppose that generator suddenly loses load. If we have one of these motors in series with a high voltage line driving an alternating current generator, suppose the alternating current generator should suddenly lose its load, how would the motor act?

C. F. Elwell: I should say this automatic brush regulator is very fast in its action. It would immediately back down to a few volts necessary to revolve that machine with no load. There may be a little sparking. I have seen some fairly large fluctuations in voltage. Of course you don't see anything to speak of in current. These regulators follow the load very fast. You may see the voltage drop from 23,000 to 19,000 volts, and as tuey throw the load in again it comes up very gradually.

Question: How quickly does the regulator work?

C. F. Elwell: There is no reason why the regulator won't work very quickly. There are a large number of cogs in the wheel, and every cog is quite small. That means that you can get a very small percentage change. It is driven by a motor at fairly high speed.

S. J. Lisberger: How are those armatures wound?

C. F. Elwell: They are drum-wound armatures. The pictures here will give a better idea of some of those points.

Mr. McCann: As to what Mr. Elwell said in regard to corona in alternating current, he speaks as though there wasn't a corona limit in direct current. In Mr. Watson's paper before the British Association for the Advancement of Science at Winnipeg, in 1909, he gave the results of a good many experiments on direct current corona losses; and he says the maximum voltage applied to the wire determines the formation of corona; and whether that voltage is applied continually in the form of direct current, or comes as a maximum twice in the cycle, doesn't make any difference. It is merely the maximum voltage that the corona depends upon, whether it is direct or alternating current. In the same way you would reach a corona limit with direct current I should think. Of course the voltage would be higher.

Another point I would like to find out about is about commutating. In a discussion of a paper on this subject Dr. Kapp seemed to think that for a concentrated commutated field motor complete compensation for armature reaction would overcome the sparking at the brushes while it was on the neutral point; and I was wondering whether they had tried that out in their generators. They evidently had not tried it out at the time the paper was published, and he suggested this as a remedy for that.

Another thing I would like to ask about is the metering of the power. In alternating current there is considerable difficulty, especially in high tension of course, in regard to rate change, and also phase angle, when you use certain shunt transformers. That would be entirely done away with. It seems as though the meter would be better and more satisfactory with direct current.

C. F. Elwell: I think Mr. McCann's point in connection with corona is well taken.

As to the point he brought up about Mr. Kapp's discussion on commutation, Mr. Kapp has had quite a little to do with the designing of these machines mentioned tonight, and they work those machines at about 50 volts between bars, which is considered pretty high voltage; and my experience has been there is very little sparking with them. The brushes follow the changes in load with almost no sparking; and as far as the attention to the commutators is concerned, they tell me they only touch them about once a year. They showed little signs of wear. Of course they are slow speed machines. That is one point that is a question. This subject has only been touched, you might say, in one spot and by one man. With many men on this thing great progress should be made. The people over there have built 25,000 volt machines for testing purposes, and they were built with rotary fields and stationary armatures; and there is no telling what we may do when we get after the problem. I am not ready to discuss the commutation problem in detail at this point.

About the metering, they have an ordinary integrating meter. All the stations that use the current have meters. They just have one meter in each place.

Mr. McCann: I was referring to the load.

C. F. Elwell: They shunt the line, and the shunt follows the voltage. The shunt would have probably only two or three volts on it, the current is constant, the voltage only varying.

S. J. Lisberger: American motor practice has always been against—or rather not in favor of the use of a shunt in connection with motors. I don't know of any American motor, with possibly one exception, that uses shunts. The claim has been that the change in the temperature in the shunt has caused such a variation as not to allow correct metering. In the case of direct current motors up to 5000 or 6000 amperes, no shunts are used. I should think that errors that might result in the use of shunts in the direct current system might render them open to as large a percentage of error as Mr. McCann mentions in the discussion of phase angle in commutation transformers.

W. F. Lamme: I saw Mr. Elwell's paper this afternoon, and looked over one particular commutator with 999 bars. It figures out that the bars were 1/16 in. thick. Putting 999 bars 1/16 in. thick in a circle, insulated for 5000 volts, it seems to me, would give a lot of trouble on account of getting out of shape. I would ask Mr. Elwell if he knows of any case of trouble of that kind. In this country we have had trouble with that kind of machinery for experimental purposes. That was one of the troubles we had, to keep the commutator in shape, but it is possible that the people in Europe have learned something we did not know.

C. F. Elwell: The commutators over there have what I would call a very deep bar; the bar is very thin but quite deep. There is not apt to be the distortion that there would be in a shallower bar; but as far as wear is concerned on the bars the ones I examined when the machines were shut down were of a nice chocolate color, and seemed to be in perfectly good order. They are all slow speed. The fastest speed is approximately 420 revolutions per minute.

Mr. McCann: The question of metering, especially with regard to calibrating meters. On an alternating current you can calibrate the induction meter so it works all right, but still if it is not put on the proper potential coil and they are not loaded properly, it won't bridge the power properly. It is practically impossible at the present time to calibrate it on the ground. It seems to me that the direct current meters could be calibrated on the ground without great difficulty. I would like to ask as to the peculiar construction of the poles of the machines. The windings are between the poles instead of on the pole itself.

S. J. Lisberger: Mr. Elwell spoke of an insulation with reference to underground cables, and gave us certain thicknesses. May I ask you to repeat the thicknesses in that class of insulation?

C. F. Elwell: With an insulation consisting of the usual tarred hemp and jute, and a little rubber, in tests they have had 4 millimeters of insulation, which they could not break down with 100,000 volts. I might mention here that they tried an insulated armored cable placed under water, with junction boxes inserted, at 300,000 volts.

S. J. Lisberger: Do they use lead sheath?

C. F. Elwell: Yes, nearly all lead sheath cable.

S. J. Lisberger: You said they used hemp.

C. F. Elwell: Yes, hemp on the outside of the cable That cable was put down about 1905.

S. B. Charters: You spoke of the possibilities of using a ground return. What are the advantages and disadvantages in that connection? There must be some, or it would be used altogether.

C. F. Elwell: I have a report of the Commission on Earth Return from which I will read in full, and you can judge for yourselves. The report says:

Report of the Commission on Earth Return.

At its last full session, 20th of June, 1909, our commission learned with pleasure that the few difficulties which

opposed a continuous trial of the transportation of energy from St. Maurice to Lausanne had been removed and that the Inspector of Telegraphs of the C. F. F., after having recognized the efficacy of the compensation cells placed as a trial in the stations at Aigle, Allon St. Triphon, Bex and Monthey, was willing that we use the earth permanently as a return conductor for the constant direct current of 150 amperes which characterizes the Lausanne transmission.

It was from that time in our power to study certain points in the program which we had mapped out since the commencement of our operations and the solution of which could only be furnished by trials of this nature. As we have already said in our last report, the trial with the earth as return commenced at 1 p. m., July 23d, 1909. We are pleased to be able to verify at the first trial that the earth as a return was faultless, and that we have been able, after 10,000 hours of actual operation to make some interesting observations.

We are naturally not able in a simple administration report, to enter into many details and quote numerous figures. This will be taken care of in our general report, at any rate the part relating to continuous current. We will be contended here with relating some of the more salient facts which we have been able to make during this last year.

A.—Earth Connections.

We recall from the very first that each of our two earth connections comprises in all 18 units in three groups of six of the same nature in parallel. At Bex as at Belmont, the six units of Group 1, consist of metallic gratings filled with slaked lime covered with large pieces of coke. The six units of Group 2, consist of cast iron pipes covered with scrap iron and those of Group 3 of cast iron pipes, but covered with large pieces of coke instead of scrap iron.

B.—Equivalent Resistance of the Earth Connection; Distribution of Current Between Connections; Wear and Repairs.

Up to the present time no modification of the number of connections in circuit at either Bex or Belmont. The service is therefore continued with 18 connections in parallel at each end of the transmission.

It was necessary to get information above all on how the connections behaved in continued service. We accordingly arranged for some continuous and some periodic measurements so that we could at all times know the equivalent resistance of each of the connections and the distribution of that current among the 18 units of each connection. Each of the latter is equipped with a recording voltmeter which records exactly, as a function of the time, the behavior of the fall of tension either between the earth connections at Bex and the auxiliary earth connection at St. Legier or between this last and that at Belmont. A recording ammeter placed in the busbar of one of the groups of the earth connection at Bex, permits us to follow the variations of the current in the circuit as well as the fluctuations of the current between groups when they exist. Finally at relatively regular intervals we measure the current in each of the 18 units and that permits us to decide if there is any wear or any other cause of derangement.

Earth Connection at Bex. This earth connection constitutes the negative pole of the return conductor. It is located in a relatively homogeneous but rather badly conducted ground, as our first experiments of September, 1906 and May, 1907, have shown.

At the first of these dates, when the Valley of the Rhone was inundated, we measured a fall of potential of 122 volts between the connection at Bex and St. Legier. The return conductor for the current, that is to say the earth, between one of the units at Bex and the equipotential surface passing through the auxiliary earth connection at St. Legier, has thus an equivalent resistance of 0.813 ohms.

In May, 1907, when the country in the Valley of the Rhone was almost dry, the fall of potential was 163 volts, between the same two points or an equivalent resistance of 1.087 ohms.

There was thus an increase of resistance of about 34 per cent between the two dates. The cause of this variation could only be the difference in the humidity of the soil. It could not be near to the earth connection, for on one hand they were at the negative pole and on the other the earth return was only used about 20 hours altogether. But if we thus fix on the cause of the variation, we have yet to explain its amplitude. Care was taken to record the level of water in the pipes which formed the essence of the earth connections, each time the potential was measured. We have thus watched the full of the potential increase proportionately as the soil dried up to a greater depth and on the contrary decrease as the phone increased or heavy rainfall near the earth connections.

When the regular use of the earth return commenced July, 1909, the Valley of the Rhone—it is always thus at this time of the year—was inundated for quite a distance around the earth connections. We measured then a fall of potential of 125 volts between Bex and St. Legier (equivalent resistance of 0.83 ohms). A curious fact is to be noted here. On returning to Bex a few days after we found a multitude of earth worms, which driven out by the current, had died outside the earth connections. We also noticed a strong liberation of hydrogen.

The indicating voltmeters showed that since this time the fall of potential increased gradually and proportionately as the waters lowered. In August, 1909, it attained an average of 130 volts; in September, 135 volts; in October, 142 volts; in November, 160 volts; in December, 165 volts; in January, 1910, 170 volts; in February, 185 volts, with a maximum of 190 volts (equivalent resistance 1.265 ohms) on 18th of February, 1910. From this on the fall of potential gradually decreased to a minimum of 115 volts (0.77 ohms) during the floods of last July.

The above few figures show that the fall of potential between Bex and St. Legier and consequently also the resistance of the corresponding piece of circuit, since the intensity of the current in this maintained constant, has varied tolerably in this first year of use. The total variation represents about 65 per cent of the minimum of 115 volts. Taking the mean values as a point of comparison of the fall of potential or resistance, we arrive at a variation of 24 per cent.

It will be interesting to see how things will go in the future. We would not be surprised to see these variations attain greater values yet for last winter was not very vigorous and the entire year has been particularly humid. We will, therefore, continue our observations and will measure, wherever we are able, the fall of potential between the earth connection at Bex and an auxiliary earth connection which we will place in the neighborhood. In this way we will know if the proportion of potential Bex-St. Legier and Bex in auxiliary earth remain constant, or if on the contrary, the variations of resistance take place only in a zone immediately around the earth connections.

The 18 units at Bex are in good shape up to the present time. We have not noticed any wear, which is not astonishing, since as before noted this is a negative pole of the path to earth. No repairs have been made to these connections. The only expense which they have occasioned, outside of the instruments which were placed there, was due to the theft of four copper wires of a few inches each, which theft was shown by the recording instruments to have taken place on the 14th of October, 1909, at 4 p. m.

This [illegible] explanation. In the case of the earth connections the potential only varies a little and in ordinary weather there is no danger in touching any one of the 18 wires which join the line to the earth. We did not therefore take any precautions to prevent access and to tell the truth did not foresee that any thief would judge conditions so accurately as to profit so adroitly. [illegible] personages had not counted on what happened as they progressed with their work. As each wire was cut the potential between conductors and any point of the ground and the currents in the wires increased considerably. It sufficed to develop in the hands, if not in the conscience, alarming and increasing prickly sensation. The sparks becoming faster and more alarming after the tenth wire was cut caused them to leave an operation which they felt must become more dangerous. We have increased this conviction by fencing off the connections and placing a sign, the tenor of which every engineer knows.

2. **Earth Connection at Belmont.** The earth connections at Belmont are located in ground which although possibly marly is better conducted than the valley of the Rhone. Since the trials of the [illegible]th and 26th of May 191[illegible], we have observed a fall of potential of about [illegible] volts between Belmont and the auxiliary earth at St. Legier. The resultant resistance between this earth connection and the equipotential surface passing through St. Legier was about 0.63 ohms.

During this year of trial the fall of potential between these same points has varied relatively little. The extreme values observed were [illegible] and 107 volts. On the other hand these variations have not followed any well defined law and this is easily explained. The ground at Belmont shelves down quite markedly. The runoff is therefore prompt and small seepage prevents large variations of the resistance of the soil. The variations of the fall of potential Belmont-St. Legier have accordingly been more variable than at Bex where the variations were of lower duration. Besides the connections at Belmont, which constitute the positive pole of the earth return path, have been partly destroyed by electrolysis and partly modified in their structure by earth slides or currents of water and it is probable that these are the principal factors in the variations of resistance in this portion of the path. The units in metallic screens suffered the most. Two of them were almost completely eaten by electrolysis and have been replaced by two units filled with coke. Three units of group 2 (pipe and scrap iron) have also suffered from wear and bad contact. The scrap iron has been replaced with large pieces of coke or coal dust. Finally [illegible] of group 3 (pipe and coke) have had to be replaced for lack of cohesion between the coke and the pipe.

These repairs have not necessitated any stoppage of service. They have been made easily and at little expense. The wear by electrolysis has been extremely small, considering that 5400 megacoulombs have passed through these units since their use as earth return.

We have already had occasion to say that the earth return has worked without any mishap since it was placed in regular service. There has not been during 14 months any derangement due to it, even at St. Maurice where the tension reaches up to 2[illegible] volts. It has not been necessary ever to resort to the two-wire service and the chief of the [illegible] service at Lausanne does not see any reason why the earth cannot be used as a return indefinitely. On the other [illegible] complaint [illegible] at Aig[illegible] St. Triphon [illegible] which have [illegible] service [illegible] [illegible] such a decis[illegible] result. The work was facilitated by the good will and co-operation of the official of the federal telephone and telegraphs, more particularly the City of Lausanne and the Chief of Electric Service.

The Commission will continue to observe in an attentive manner the working of the St. Maurice-Lausanne transmission and will not fail to make any useful indications.

A. J. Bowie: I would like to ask if there is any trouble with the insulation of the small motors on the line?

C. F. Elwell: The earlier generators and motors were mounted on regular insulators, that is, a petticoated insulator put upside down, and it was found that these were cracked, and now they adopt the method of mounting the whole machine on a slab of insulation, covering the whole floor around the machine with a couple of inches of asphalt. The floor of the house is covered with vitrified tile. It has the disadvantage, that the machine becomes charged statically.

Question: How about the effect of electrolysis on gas pipe and water pipes?

C. F. Elwell: I mentioned before, no repairs have been made to those in fourteen months.

Question: Wouldn't it attack them if they happened to be adjacent?

C. F. Elwell: They evidently had that in mind in making the earth connection. St. Maurice is quite a fair sized town, and so is Lausanne, and they went out of both places several miles before taking to the earth as a conductor, evidently to avoid any trouble from electrolysis in St. Maurice and Lausanne. Between those two cities there was no town of any importance.

A Member: In regard to water pipe electrolysis, I read an article about this system. The way they overcame that was to insulate their cable down to a ground plate, which was several feet below the surface of the ground. In that way the current passed in a path that was considerably below the adjacent pipes and so forth, and in that way it had no effect. They insulated the cable down to the ground plate.

S. J. Lisberger: What did you say was the maximum voltage they had current on any one of these direct current systems?

C. F. Elwell: The existing system, the one that has been in operation for five years, 57,600. They employed that on the same type of insulators that they used on the 26,000 a.c. line.

S. J. Lisberger: Then they are not capable of delivering very much power?

C. F. Elwell: With 150 amperes at 93,000 volts they will have [illegible] kilowatts. I don't see why they could not generate 17,000 kilowatts.

Question: I would like to ask, referring to the diagram, does each of those stations represent a generating plant?

C. F. Elwell: No, these represent generating stations, and these three receiving stations. This diagram shows the connection of one group. Here are the armatures in series, and the ground points of the armatures are grounded to the system through these coherer resistances, and the only apparatus, as you see, is this commutator form of switch. You swing it round in the upper position and the line is short-circuited and you swing it sideways and it is in series. That is all of the details that exist in connection with the set.

Question: The distance between the generating and the receiving stations is what?

C. F. Elwell: 112 miles, and you can see the voltage ratio in that connection. They have for five years worked 112 miles with 57,000 volts.

A. J. Bowie: Has Mr. Elwell any figures as to the relative cost of machinery of this direct and alternating current?

C. F. Elwell [illegible]

JOURNAL OF ELECTRICITY
POWER AND GAS

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Entered as second class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

In response to the pressing need for a simple and practicable treatise on the best methods of burning fuel oil, Mr. E. N. Percy has prepared the non-technical account which begins in this issue and will continue for several more. It comprises a condensation of the author's wide observation of current practice and consists largely of diagrams and illustrations of good and bad methods. Further contributions on the practical side of this question are invited from our readers.

The wide-spread reports that the United States Navy has decided not to use the steam turbine in battleships on account of its lower efficiency as compared with the reciprocating engine have created a false impression in the public mind. The newspaper reports neglected to state that this low efficiency was due to the slow speed at which the vessels were run and to which the turbine is manifestly unfitted, as it cannot then be operated at maximum efficiency. This type of engine has materially increased the speed at which cruisers and scouts may be safely and continuously driven and is finding a wide field in marine use.

The possibility of a wider application of the ground return for direct current machines is indicated in the discussion on high tension direct current transmission elsewhere in these columns. The drop in voltage in the thirty-five mile transmission between St. Maurice and Lausanne in France is eight per cent with copper return and five per cent with earth return. Direct current amounting to 150 amperes was transmitted at 27,000 volts during fourteen months without serious mishap.

Electric power has effected an annual saving of $150,000 in the operation of six logging camps in Coos County, Oregon, which formerly employed steam power. These camps represent an investment of $450,000 so that this saving would pay for the entire investment in three years. This statement provoked so much interest at the recent Portland convention of the Western Forestry and Conservation Association that a committee was appointed with instructions to confer with the electrical manufacturers for the purpose of conducting practical experiments upon the application of electricity to logging.

Danger of Public Operation of Public Utilities.

Seldom have the past results of public control of public utilities been so concisely summarized, their present so clearly portrayed, and their future so brilliantly forecasted as in Geo. A. Damon's address printed elsewhere in this issue. Mr. Damon's wide experience with the New York Commission, on the Pittsburg traction board and at Los Angeles has well qualified him to speak on this subject and gives to his remarks the added force of authority. Adequate service, in his opinion, is the great end in view and to his all other interests should be subordinated. Rate fixing is the last of the fundamentals to be considered. His suggestion with reference to the

dangers of public operation and the wisdom of university co-operation are especially opportune and worthy of careful consideration.

He contends that, while governmental regulation of public utilities may finally lead to governmental ownership it would be most injudicious to extend these powers to governmental operation. That public ownership will be the ultimate outcome of regulation few thinking men will deny, if for no other reason than the withdrawal of private capital into more lucrative fields. The moneys which should logically accrue from public participation in profits would here find appropriate investment. Such public ownership is the limit to sane socialism, beyond it, madness lies.

The folly of public operation is exemplified by the miserable service now being given by the British telephone system which has been under the supervision of the Postoffice Department and which will probably be taken over from the National Telephone Company during the next year. In the words of a Bostonian who has recently returned from England "the employees, not knowing what is to be done with them, are careless, the unhappy subscribers feel that they are going from the frying pan into the fire." So long as politics hold sway over governmental offices, good service cannot be their distinguishing feature. As a substitute Mr. Damon proposes that the operation be turned over to private companies working on a bonus basis. His suggestion has the hearty endorsement of many operating men.

His proposal of university co-operation with the work of the public service commission is in line with the Wisconsin plan of turning over the technical problems to the faculty of the State University. Excellent results have followed this practice and we believe the suggestion will meet the approval of all the well-wishers for the recently established commissions in the Western States.

Western Water Laws

Many Western power companies will be interested in the decision of Judge J. T. Ronald at Seattle last week whereby the Yakima Irrigation Company was enjoined from diverting water from the south fork of the Snoqualmie River in accordance with the petition of the Seattle-Tacoma Power Company. The power company owns the land on both sides of Snoqualmie Falls at the site of its hydroelectric plant and claims the right to the use of all the river's natural flow. The court held that the riparian right is a property right and that the irrigation company, in order to procure any part of the flow that the power company does not use, must come into court by condemnation proceedings.

Thus is another link forged in the chain which bids fair to bind the West to the old English idea of riparian rights as contrasted to the California miner's right of appropriation. New evidence is here presented that the West is fast becoming a settled community and now feels the need for the laws more appropriate to that condition. A little history may not be amiss.

From the earliest times running water has been considered as free as the air and the light or as the birds that fly therein until it becomes private property by capture. The figurative beauty implied in the expression "taming the power of the water-fall" is surpassed in vividness only by its literal truth, "one of those truths spoken from the chest" as our German friends might remark. For what wandering animal is wilder or more ownerless than unappropriated running water, more amenable to man's control or freer when it escapes from restraint. This analogy is still further borne out by the many points of similarity between the game laws and those concerning water.

These laws, though legion in number, may be classified under two heads, the laws of riparian rights which the Romans bequeathed to the British and which they in turn transmitted to the early American settlers, and the laws of the right of priority of discovery, location and appropriation, which were an outgrowth of the conditions endemic to the California argonauts. The former, the English common law system, is applicable to well settled communities where private land holdings predominate; the latter, the crystallized customs of the pioneer miners, was adapted to the Western States and Territories where public lands predominated. Consequently we find that the right of appropriation was early incorporated in the constitutions of all the Western States in conformity to the precedent set by California.

Later, as more land passed into private ownership during the era of rapid development, arose questions contingent upon private land holdings and also upon the multiplicity of appropriations along the same stream. The early laws of appropriation proved inadequate to untangle this skein of legal controversy. The principles of riparian rights sufficed to settle many of these cases and so California again took the initiative in forming new laws to meet these new conditions. Many other Western States soon followed this example, but others, notedly Colorado, still cling to the laws clustered around the right of appropriation until today there are two opposing forces, those who favor the combined system of appropriation and riparian rights and those who recognize only the right of prior appropriation.

The former, or "California doctrine," rules in that State as well as in Washington, Montana, the Dakotas, Kansas and Oklahoma. The latter, or "Colorado doctrine," governs in Colorado, New Mexico, Wyoming, Utah, Idaho, Nevada, Arizona and Alaska. Oregon, Nebraska and Texas have partially adopted the laws of riparian rights but still favor the right of appropriation.

Opinion differs greatly as to which doctrine is more favorable to the development of the West or whether either tends to retard it. Recent decisions of the U. S. Supreme Court "recognize the difference of climate and soil which render necessary these different laws in the States so situated." However, it cannot be but a matter of a short time before the rapid settlement of the great arid West will quiet these contentions in favor of the dual system, as indicated by Judge Ronald's decision, especially as they are now being overwhelmed in the far greater question of federal control. But this is another story.

PERSONALS.

J. A. Cranston, manager of the Portland office of the General Electric Company was a recent San Francisco visitor.

W. Brewster Hall, representing Pass & Seymour of Solvay, N. Y., has been calling on the trade at San Francisco.

C. E. Groesbeck, one of the vice-presidents of H. M. Byllesby & Co., with headquarters at Portland, Ore., was a recent San Francisco visitor.

Hans F. W. Rasmussen, formerly with Stone & Webster at Boston, has joined the new business department of the Pacific Gas & Electric Company.

S. P. Russell, manager of the electrical department of the H. W. Johns-Manville Company, spent the past week on a business trip through central California.

J. H. Hansen, designing engineer with the Pelton Water Wheel Company, spent the past week at Los Angeles and vicinity inspecting the plants of the Pacific Light & Power Company.

H. A. Lardner, Pacific Coast manager for J. G. White & Co., of New York, has returned to his San Francisco office after visiting Tonopah to make an engineering report on a mine project.

Frank Loomis has resigned his position with the Pacific Coast offices of the Holophane Company to take charge of the electrical department of H. W. Johns-Manville Company's Portland offices.

Geo. R. Murphy, manager of the storage battery department of Pierson, Roeding & Co., has just returned to San Francisco after spending six weeks on a tour of the Eastern and Northwestern States.

I. W. Booth, who is interested in the manufacture of the Lombard governor, has arrived at San Francisco from Boston and is visiting Pierson, Roeding & Co., the Pacific Coast agents for his company.

Robert Sibley and Rudolph W. Van Norden inspected the Borel plant of the Pacific Light & Power Company, this week. Mr. Sibley continued to Los Angeles while Mr. Van Norden returned to San Francisco.

James N. Campbell has taken charge of the supervision of the construction of the Oakland & Antioch Railway. His future headquarters will be at J. G. White & Co.'s construction office, 103 Edith street, Oakland.

C. Remschel has given up his connection with the American Electric Company at Seattle and will put in a large stock of electrical equipment and supplies in a new store he plans to open. He spent the past week at San Francisco.

Fred L. Johnston has resigned as city engineer of Santa Barbara, Cal., to become supervising engineer over the transmission line which the Southern Sierra Power Company is building between Bishop and San Bernardino, Cal.

F. A. Richards, of the railway department of Pierson, Roeding & Company, has returned to the San Francisco office from San Diego, where he secured an order from the San Diego Electric Railway Company for 48 double trucks for electric street cars. A fine reinforced concrete power station, equipped with the latest type of steam turbine generator, is being completed. W. Clayton, vice-president and general manager of the company is authority for the statement that numerous extensions of the system will be made within the next few years.

Wynn Meredith, Pacific Coast manager for Sanderson & Porter, has gone to Victoria, B. C., to canvas the tenders opened Dec. 15, for the construction of a new water supply system. In his capacity as consulting engineer for the corporation of the City of Victoria, Mr. Meredith drew up the [illegible] specifications and contract forms making a volume [illegible]. The cost of this gravity system, which is to [illegible] from Sooke Lake, is estimated at from $1,500,000 to [illegible]. About sixteen million imperial gallons per day are expected to flow through the 26-mile conduit.

FIRST MEETING OF ELECTRICAL DEVELOPMENT LEAGUE.

The first regular meeting of the newly formed organization of San Francisco electrical men, to be known as the "Electrical Development League" was held at Tait's Cafe on December 12 with a large attendance. Reports were received from several committees and their recommendations adopted as to Constitution and By-Laws and officers Geo. C. Holberton was elected president, H. V. Carter, vice-president and E. B. Strong, secretary-treasurer. The executive committee consists of these gentlemen together with C. C. Hillis, P. Decker, J. A. Vandegrift and W. W. Hanscom. Appointments on the various committees will be announced later.

This is an organization of individuals and not firms, its membership has no geographical limitation and all Pacific Coast electrical men are especially invited to join. Meetings are to be held monthly at the call of the president, the next being scheduled for January 9, 1912, at Tait's Cafe. Official headquarters are at the secretary's office, rooms 106 112 Rialto Building, San Francisco.

OBITUARY.

George Barclay Moffatt, the man who conceived and carried to completion the Oregon Electric Railway project and who was the first president of that road, died at Portland, Ore., December 4, aged 57 years. He was identified in an official capacity with most of the large financial powers of New York, including the financial house of White, Weld & Company, and the Electric Bond & Share Company, of New York, of which he was a director. Until just before his western trip he was a director in the American Telephone & Telegraph Company. The banking institution of which he was the head, financed and controlled many industrial enterprises all over the country. Among the more important of these are the Portland Power & Light Company, the Portland Gas & Coke Company, the American Power & Light Company, of New York, and the Kansas Gas & Electric Company. He was a director of the two last named companies at the time of his death.

In an individual capacity and in association with W. A. White, his father-in-law, he operated and controlled the Washington Water Power Company, of Spokane, which supplies power to the street railway system of Spokane, a suburban line from Spokane to Medical Lake, and large power plants at Post Falls and in Spokane.

ELECTRICAL CONTRACTORS' NOTES.

Frank Somers, manager of the Century Electric Company, of San Jose, was in San Francisco last Tuesday.

H. E. May, of the Electric Supply Company of Sacramento, was present at the Electric League Luncheon, Tuesday.

Contracts amounting to $127,941 have been let for an apartment house on Franklin, Page and Market streets, by Albert Lansburgh, architect. The electrical work will run about $5500.

W. S. Hanbridge, secretary-treasurer of Electrical Contractors' Association reports that a meeting of all the electrical contractors in the southern part of the State was held a Los Angeles, Saturday, December 2d and it was well attended from all points. After the meeting the contractors and their ladies became the guests of Mr. Chas. Hall, the general representative of the Illinois Electric Company and viewed the electrical show. The meeting was a great success and a vote of thanks was extended to Mr. Hall.

The Newberry, Benheim Electric Company of San Francisco and Los Angeles, were awarded the wiring for the Pasadena High School for the sum of $21,000.

INDUSTRIAL

WESTINGHOUSE ELECTRIC CHAFING DISHES AND FRYING PANS.

The rapidly increasing use of electrically heated apparatus for domestic purposes has led to the design of various devices and modifications of those already designed. Examples of these are shown herewith in the frying pan and the blazier type chafing dish manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Penn.

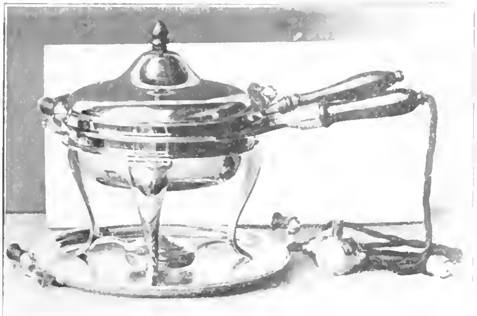
The frying pan is one of the most convenient cooking utensils that can be offered for use in homes, restaurants, hotels, etc. It is not only a complete frying pan, capable of cooking everything that can be fried in the ordinary manner, but it can also be turned into an electric disc-stove by simply inverting it and is then suitable for all kinds of light cooking, toasting, and similar uses.

Electric Frying Pan

It is made of sheet steel and has a polished metal handle. The heating element is in the bottom of the pan and is hermetically sealed between steel walls so that it is completely protected from oxidation. The pan can be easily cleaned.

The pan heats quickly and can be run at three different temperatures—high, medium, and low. The desired temperature is obtained by means of an indicating push-button switch.

The stand is made of aluminum and is so designed that the frying pan can be run at full heat without injuring the surface of the table on which it is supported. The whole outfit is light.



Electric Chafing Dish

The Westinghouse blazier type chafing dish is the most improved form of this ever popular utensil. In it there is absolutely none of the danger from fire and explosion which is always present when alcohol is used. The heat is uniformly distributed over the bottom of the pan, thus eliminating the overheated center and cold sides which are unavoidable when heat from a flame is used.

The dish can also be operated at three heats—high, medium, and low—and the temperature at each heat is always the same so that results once obtained can always be duplicated. It is always ready for use and consumes so little current that it is more economical than the alcohol-heated dish.

This chafing dish is similar to the ordinary type except that it has three pans instead of two—a water pan, a food pan, and a blazier. The water pan and the food pan are the same as used with the ordinary alcohol chafing dish.

The blazier contains the heating element hermetically sealed in the bottom. It is similar to the food pan in appearance and can either be used as a food pan for operations requiring high temperature, as in frying, or it can be filled with water and used to heat the food pan, which fits within it, when mild heat is wanted.

An indicating plug switch controls the temperature. The high heat is ordinarily used to bring the chafing dish to the desired temperature. The low heat will keep water boiling after the boiling point is once reached and is useful for keeping food warm. The medium heat is the highest that is usually wanted for most cooking in the blazier.

All metal parts are handsomely finished in polished nickel or copper. The handles are ebonized wood. The blazier is designed to fit the most popular sizes of chafing dishes and contains all the parts necessary for electrical operation. By its use the most popular makes of alcohol chafing dishes may be operated by electricity with no changes of any kind.

TRADE NOTES.

Gas Kai is the title of a new monthly magazine devoted to the gas interests of Japan and published at Tokio under the editorship of S. Fijisaki.

Electrocraft, heretofore published at Detroit, Michigan, as a monthly magazine for electrical contractors has been absorbed by the Electrical Review and Western Electrician of Chicago.

NEW CATALOGUES.

The Bridgeport Brass Co. of Bridgeport, Conn., are sending out postal cards telling of the advantages of "Phono-Electric" as trolley wire insurance.

Circular 1198, describing alternating current waterwheel generators, has been issued by the Westinghouse Electric & Manufacturing Company of East Pittsburg, Pa. The publication illustrates and describes the different types of generators, both vertical and horizontal, for waterwheel drive manufactured by that company.

The Sterling Electrical Mfg. Co. of Warren, Ohio, have issued an attractive treatise on the Mazda lighting system entitled "From Lost Hole to Light On." The cost data embodied is especially valuable. The same company has issued a handsome pamphlet on "Warren Beautiful," the first city in the United States to adopt Mazda street lighting exclusively.

The Kellogg Switchboard & Supply Company, Chicago, are issuing a unique postal card booklet, with factory and branch office views that emphasize the personnel of its sales representatives. This little booklet, attractively printed in two colors, is a part of an ordinary mailing card and gives views of the factory buildings, mentioning briefly the equipment, the branch offices, with complete stock and shipping facilities

NEWS NOTES

INCORPORATIONS.

BAKERSFIELD, CAL.—Bakersfield Water Company, $100,000 by E. L. Foster, L. E. Jordan, H. R. Person.

HOLTVILLE, CAL.—Imperial Southside Water Company, $200,000, shares $10 each, by C. D. Hartshorn, F. S. Best.

HOOD RIVER, ORE.—The Hood River Gas & Electric Company has been incorporated with $100,000 capital stock.

LOS ANGELES, CAL.—Needles Gas & Electric Company, $10,000, subscribed $300, by H. Torchiana, B. L. Devos, A. Mildreta.

SAN BERNARDINO, CAL.—Citrus Belt Gas Co., $1,500,000, subscribed $500, by F. P. Morrisin, E. D. Roberts, A. M. Ham and Z. T. Bell.

SAN FRANCISCO, CAL.—Merced River Electric Power Company, $10,000,000, by L. M. Cove, H. L. Breed, Chas. Fress, S. Hamilton and J. L. Bowes.

SAN FRANCISCO, CAL.—Haller-Cunningham Electric Company, $10.000, shares $10 each, subscribed $5000, by E. T. Cunningham, J. P. and G. F. Haller.

BOISE, IDAHO. The Southern Idaho Light, Heat & Power Company has just been incorporated with a capitalization of $20,000 000. The prime movers in the organization are capitalists of Portland, Me.

ILLUMINATION.

CHICO, CAL.—Sealed bids will be received by the Clerk of the Board of Trustees up to December 19th, 1911, for lighting the city of Chico.

PETALUMA, CAL.—The Pacific Gas & Electric Company will shortly commence work extending the electric line for two miles out in the vicinity of Church's Hill.

CRANBROOK, B. C.—The Empire Electric Company has secured the contract from J. McKay, of Athalmer, for the installation of an electric light plant at Athalmer.

REDLANDS, CAL.—It has been decided to install ornamental lights in the business section of the city. The cost is to be borne by the property owners and the city proportionately.

BOISE, IDAHO.—The Boise Gas Light Company's plant and business has been purchased by Kelsey, Berwer & Company, of Grand Rapids, Mich. Many improvements in the plant will be made.

BELLINGHAM, WASH.—The joint committee of the water board and the city council has decided to install an auxiliary lighting plant in connection with the city's power station which operates the electric pumps of the water department.

SAN JOSE, CAL.—The Sierra & San Francisco Power Company, has established offices in this city. The main line of the company passes through Alviso, and its nearest point to San Jose is about ten miles, but a branch line will be built into the city in a short time.

TROPICO, CAL.—The City Council has passed a resolution that public interest and necessity demand the construction and completion by the city of electric works. The cost which will be about $20,000, is too great to be paid out of the ordinary annual income of the city.

BELLINGHAM, WASH.—An ordinance has been introduced to the City Council, providing for an appropriation of $6000 for the installation of a municipal lighting plant. City Engineer Whitney asserts that a municipal plant will reduce the cost of arc lights from $54 to $25 per year.

MARTINEZ, CAL.—The Pacific Gas & Electric Company is spending several thousand dollars repairing and strengthening the lines between here and Concord. New wires are being strung along the line and steps being taken to protect the line from falling limbs, which in winter time cause the breaking of the power lines.

TRANSPORTATION.

SAN BERNARDINO, CAL.—A bonus of $14,000 has been raised for building a trolley line from the northwest section of the city to the business district. It will be tendered to the Pacific Electric Company, and if refused will be offered to other companies.

WOODLAND, CAL.—An ordinance granting the right of way for the West Side Electric Railroad over all the public roads covered by the surveys has been adopted by the Supervisors in the name of J. Reith Jr., E. L. Sisson, H. W. Manor and L. P. Klemmer.

McMINNVILLE, ORE.—It is reported that the west side lines of the Southern Pacific will be electrified in the near future. It is understood that the lines will be equipped for electric cars as far as this place, both by way of Forest Grove and also on the Yamhill division by way of Newberg.

SANTA CLARA, CAL.—Manager F. F. Chapin of the Peninsular Electric Company has received word from Paul Shoup, manager of the Southern Pacific electric lines, that the application for an electric line to connect Santa Clara with the interurban system of Meridian Corners has been granted.

LA MESA, CAL.—Work on the San Diego, El Cajon & Escondido electric line is being pushed. G. W. Purcell, president of the San Diego & Escondido Electric Company, states that plans for trestles are being prepared in the office of the company. There will be five trestles in the strip between La Mesa and San Diego.

SAN FRANCISCO, CAL.—The Board of Public Works has awarded the contract for furnishing 43 cars for the Geary Street Municipal Railway to the W. L. Holman Company, the only local bidder, for $337,000. It is understood that the matter will go to court since the Holman Company was not the lowest bidder, its demand being $50,000 in excess of that of the Jewett Car Company of Newark, Ohio.

PHOENIX, ARIZ.—A franchise has been granted to the Salt River Valley Electric Railway Company to connect Phoenix with the northeast part of the valley, the initial line probably terminating at Scottsdale. It also proposes to build a line to Glendale and the Northwest, and eastward to Tempe and Mesa. Entry to the city is to be by way of Adams streets. The promoters state that the power will be electricity from storage batteries.

BOSTON, MASS.—Stone & Webster report as follows on the October operations of the following companies: Puget Sound Electric Railway—Gross earnings, $154,752; decrease, $7008; net earnings, $17,826; decrease, $2854; surplus over charges, $6166; decrease $4497. Seattle Electric Company—

Gross earnings, $461,501; decrease, $7,532; net earnings, $201,-118; decrease, $28,275; surplus over charges, $85,184; decrease, $34,296. Whatcom County Railway & Light Company—Gross earnings, $34,506; decrease, $1114; net earnings, $16,-407; decrease, $1,071; surplus over charges, $5637; decrease, $688.

FRESNO, CAL.—Manager A. G. Wishon of the San Joaquin Light & Power Company, confirms the fact that a railroad is being built to Big Creek. The cost of the road will be about $1,000,000. It is not yet certain that the road will be brought all the way to Friant. It may be brought down to the plains by way of Little Dry Creek, and connect up with the Southern Pacific at the Fresno copper mine. The route cannot be determined until the surveyors get through with that part of it.

SAN FRANCISCO, CAL.—Suit has been instituted by the State of California against the United Railroads for the forfeiture of the franchise in California street from Kearny to Market streets. The complaint was signed by Attorney General U. S. Webb and City Attorney P. V. Long. Assistant City Attorney D. S. O'Brien is the nominal plaintiff. On account of the disuse of the rights the State asks that the franchise be declared forfeited and that the United Railroads in addition pay a fine of $5000.

TRANSMISSION.

SANTA CLARA, CAL.—An ordinance was passed granting to D. O. Druffel, a franchise to construct and maintain pole lines and conduits for the purpose of transmitting electric current for power purposes.

SUISUN, CAL.—The Great Western Power Company, which has built an electric line from the Sierra Nevada Mountains to the bays, is considering the proposition of building a cable across Carquinez straits for the purpose of distributing its power in Solano and Napa counties.

WASHINGTON, D. C.—Early action is expected by Secretary Fisher on the application of the Great Western Power Company for permission to develop 55,000 h.p. of electricity on Feather River in Butte Valley, in the Plumas National Forest, Cal. The Forest Service has approved the plan as outlined in the application of the power company.

HOOD RIVER, ORE.—The Hood River Applegrowers' Union has purchased from Joseph A. Wilson his 175 horsepower waterpower system. The union plans an increase of from 300,000 to 500,000 boxes in its storage capacity next year and the power will drive the ice and cold storage machinery. The power system, the water of which is secured from Indian Creek, a tributary of Hood River, which empties into that stream near the city of Hood River, was constructed by Mr. Wilson in 1905. In addition to the power furnished to the growers' union, water and power is furnished to eight other business concerns in the city, and water to the O.-W. R. & N.

HOOD RIVER, ORE.—Justice of the Peace A. C. Buck dismissed the criminal charges preferred against T. E. Verco, a laborer, and Charles W. Gill, line foreman of the Hydro-Electric Company, by Albert S. Hall, Hood River, manager of the Pacific Power & Light Company, for an alleged criminal destruction of property. The Hydroelectric Company's new line, the poles of which the laborers were setting into Portland, parallels the line of the Pacific Power & Light Company, which carries a current of 2200 volts. At the Indian Creek bridge, in order to raise their line above that of their competitors, the Hydro Company was forced to erect poles 65 feet in height. The foreman, Gill, found that it would be impossible to set the poles without guy wires coming in contact with the live wires, and to prevent danger to men and probable damage to the Pacific Power & Light Company's wires, he removed plugs a short distance from where his crew of men was at work and cut off the current, which, according to statements of Hill, left 60 of their customers without electrical energy for a period of about four and a half hours. This act was alleged malicious. The removal of the plugs was admitted by the defendants, but a lack of malice was avowed.

TELEPHONE AND TELEGRAPH.

SUSANVILLE, CAL.—The California Telegraph & Telephone Company has been busy lately putting in operation new lines and exchanges.

WATSONVILLE, CAL.—The people of the Carlton district have about completed arrangements for the installing of a private telephone system in that section, which will connect with the central office of the Pacific States Telephone & Telegraph Company, at Watsonville.

TACOMA, WASH.—Following President Theodore N. Vail's visit here this week, the Bell telephone interests today wiped out competition in Tacoma and Bellingham at an auction under Federal Court authority. The holdings of the Home Telephone Company of Puget Sound at Tacoma and Bellingham were purchased by the Sunset Telephone Company, a subsidiary of the Pacific Telephone & Telegraph Company, for $550,000. Mayor Seymour wanted the city of Tacoma to organize a holding company and purchase the Home telephone plant, but could not do so without authority of the Legislature. He says he has an understanding that the city can purchase the Home plant from the Bell interests if Tacoma so desires later.

WATERWORKS.

ELMA, WASH.—All bids for the construction of the water system were rejected by the City Council.

STEVENSON, WASH.—The City Council has passed an ordinance providing for the purchase of the waterworks of the Stevenson Water & Improvement Company.

SPOKANE, WASH.—Plans are being drawn by a Spokane engineering firm for a waterworks here costing about $11,000 to be located on Howerton hill, northwest of the town.

EUREKA, CAL.—There has been filed with the County Recorder a water appropriation of 5,000,000 inches, made by K. Geer on water flowing in Ben Vaissade creek, to supply inhabitants of the city of Blue Lake.

WOODBURN, ORE.—The sale of $25,000 waterworks bonds was negotiated here by the City Council to an eastern bonding company The water system will be taken over by the city and extensions to the amount of $15,000 made during the next year.

KLAMATH FALLS, ORE.—The city intends to take up 500 miner's inches of water from the springs at Rock Creek and Aspen Lake, which are 30 and 28 miles distance respectively. The water will be taken from nine streams that are capable of supplying the city's needs for many years. It will be piped to this city.

REDLANDS, CAL.—Engineer F. E. Trask, appointed by the City Trustees some time ago to take up plans for a municipal water system for Redlands, to investigate the value of systems that can be acquired and to report on these systems, has accepted the contract and will begin work in a few days. He will receive $3000 for his work and $200 additional in case bonds are voted and he carries out the work on the system.

ALPHABETICAL INDEX TO ADVERTISERS

Journal of Electricity

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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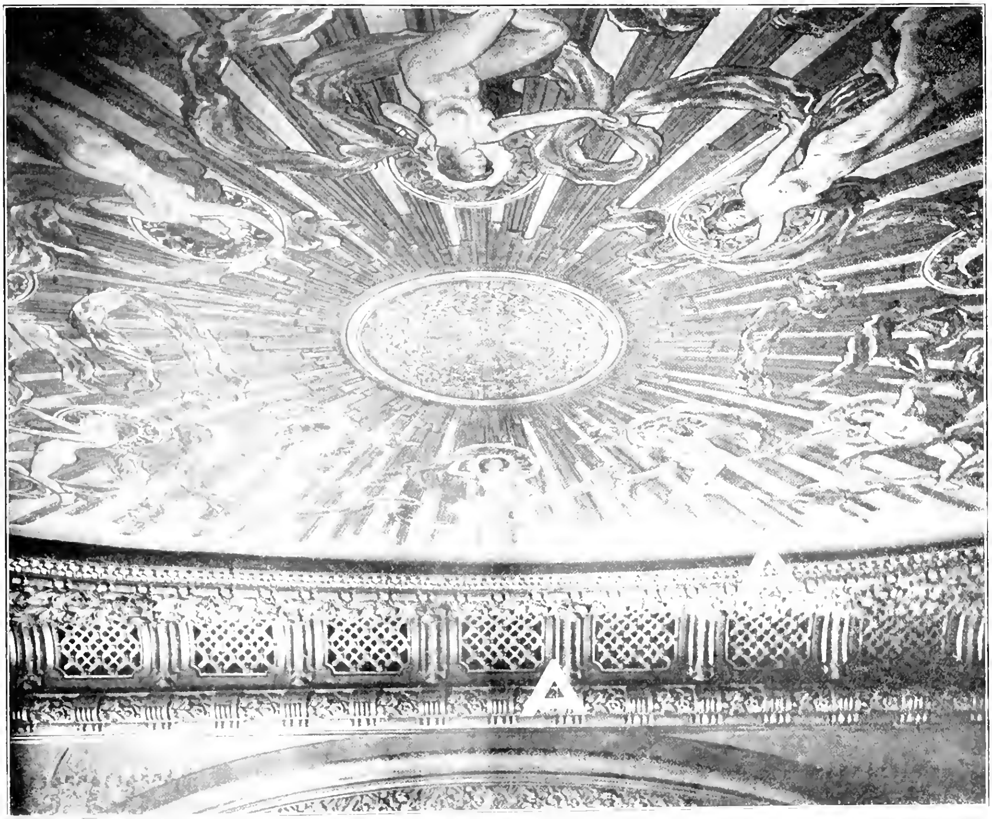
ELECTRICITY IN THE CORT THEATER

BY CHAS. T. PHILLIPS.



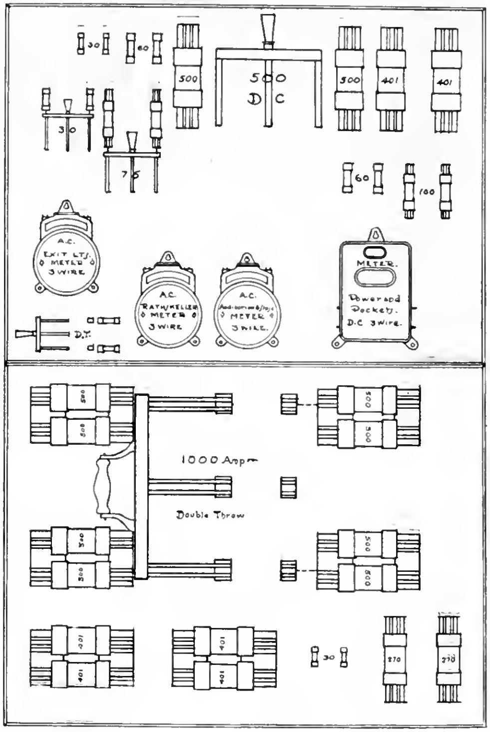
Cort Theater Ceiling Panel. Lights Concealed in Mouldings at A. A.

The Cort Theater, situated on Ellis street near Market, San Francisco, which was recently opened, is distinctive from a great many other theaters in the simplicity of its electrical equipment. The general tendency in large theaters is to complicate the equipment, but, in this case, nothing was installed except that which was absolutely necessary. While the installation is simple, nothing is omitted that is necessary for the operation of any show the house may book.

The switchboards are built of oil-finished slate, mounted on angle iron frames. The service enters underground, and consist of two sets of d.c. and one set of a.c. feeders, which are brought to the service

and meter panel, which is placed in one of the side entrances, and is close to the stage door and the street. This makes the service switches readily accessible to the fire department, as required by city ordinance.

The service and meter panel consists of two slabs of slate, mounted in the concrete wall. The front has sheet iron and glass doors, and open into the side entrance. The rear is covered with a sheet iron cover fastened with machine screws. This cover can be removed to get at the connections which are all on the rear of the panels.



Service Panel.

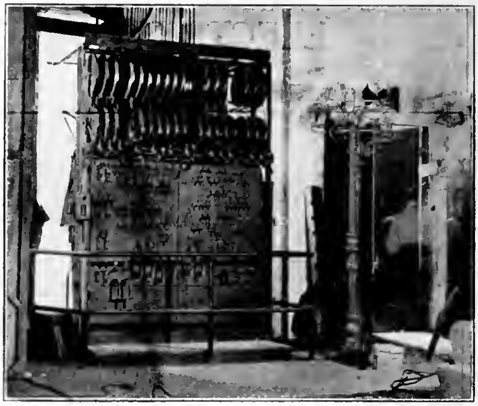
All switches are of the knife blade type, and are so arranged that all lights can be thrown from one set of service feeders to another. All lights on the facade, the sign, offices, exits and stair lights are controlled from a panel in the box office.

From the service panel the d. c. and a. c. feeders are carried in conduit to the stage switchboard, which is situated on the west side of the stage, near the proscenium opening. This switchboard consists of two panels and is very compact. All switches are double pole, the majority being 250 volts, the neutral being carried through without switching. All fuses are mounted on the rear of the panels with the exception of the 60 ampere fuses, for the stage pockets, which are mounted on a panel in a cabinet on the wall at the rear of the switchboard.

The majority of the switches are of the double throw type, throwing the auditorium lights from one master switch to another, and, in the case of stage pockets, moving picture booth, musicians' lights, and the spot light outlet in the gallery front, are thrown from a master switch ahead of the master.

There are nearly 1300 lamps in the foots, borders, and proscenium strips. These lights are divided into four colors; red, white, blue and amber, the white predominating.

There are 13 two-gang stage pockets on the stage, calcium bridge and fly gallery, one receptacle in each for arc lamps, and the other has a dimmer connection. The latter can be used for arc lamps also, if necessary. In this case, there are two single pole short-circuiting switches on the rear of the switchboard to short circuit the dimmers.



Stage Switchboard

The dimmers are arranged in two banks, and are mounted above the stage switchboard. All levers and master levers are on one shaft, 74 in. from the floor. All dimmer levers and switches can be operated standing in one position, without stooping or stretching. This is a great advantage, as the operator soon learns his levers and switches, and can watch the stage and operate the board without changing his position.

Near the stage switchboard, is a stage manager's switchboard, upon which is mounted push buttons with leads to the different dressing rooms, for buzzers, and signal lights in the fly gallery, orchestra pit, O. P. stage and buzzers in the lobby and rathskeller.

In the lobby, there is a switch controlling a modern carriage call. These calls consist of a rectangle frame, one mounted on each end of the marquise. When a numbered coupon is inserted in the switch, a corresponding number, in small incandescent lamps, appears on the frame.

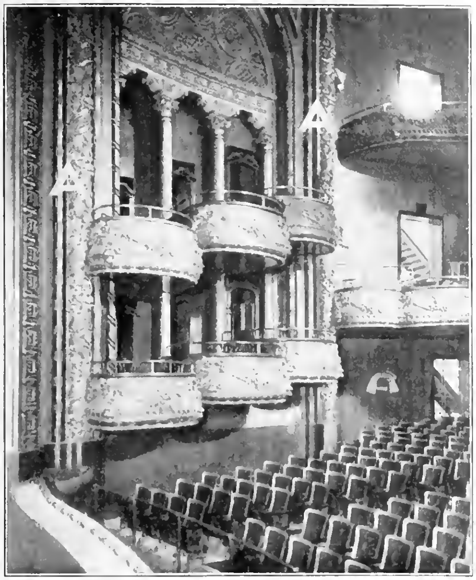
All lighting, with the exception of the rear of the balcony and gallery, is concealed in coves, cornices and mouldings.

The color scheme in the auditorium is of golden brown and old gold. While this is very beautiful and pleasing, it is not particularly adapted to indirect lighting, on account of its capacity for absorbing light.

The coefficient of reflection being quite low, a great deal more light is used than would be necessary if the color scheme were lighter. There are over 1600 sixteen candle-power lamps in the auditorium alone. Carbon lamps are used almost exclusively throughout,

there being a number of reasons why a more efficient lamp could not be used.

The facade, with the exception of seven standards, is illuminated entirely with concealed lights. This is a new scheme for the lighting of building fronts, and the effect is most pleasing. This method would not be practical, were it not for the fact that the entire front is cement, finished smooth, and tinted in light cream.



Cort Theater Illumination, Lights Concealed in Mouldings at A. A.

There are over 1400 lights on the front, exclusive of the sign and the standards. These standards are not a part of the lighting scheme, but are an architectural feature.

The balance of the house, such as lobby, retiring rooms, etc., are lighted with fixtures, the box office having one indirect lighting fixture. The motor equipment consists of ventilating fans, air washers, vacuum cleaner and sump pump. There is a complete system of intercommunicating telephones, connecting all parts of the building.

The entire electrical equipment, was installed by the Metropolitan Construction Company, from plans and specifications prepared by the author.

LOS ANGELES AQUEDUCT TUNNELING NEARLY COMPLETED.

The completion of the boring of the tunnel on the Little Lake division of the Los Angeles aqueduct this week, known as Tunnel No. 10-A, is the practical end of such work on the great enterprise. This is the fifth longest tunnel on the work, being a clean bore of 5960 feet. The longest tunnel is the Elizabeth Lake, nearly 27,000 feet. A total of 42.25 miles have been completed, leaving only two small tunnels, one in the Saugus division and another in the Grapevine division, both aggregated only .60 miles, to be finished.

THE GAS POWER FIELD FOR 1911.[1]

BY ROBERT H. FERNALD.

The past year of the Gas Power Section has been one of continued prosperity. The progressive policies pursued by the executive committee and the various technical committees during the four short years since the birth of the Section have placed it definitely on a basis that assures its future. The reason for its being and the firm belief in a large future for the organization are readily understood by reviewing briefly the steady, healthy development of gas power during the past year—a year that places gas power for large units well beyond the uncertainties of the purely experimental period.

Large Gas Engine Units.

The development of large gas engine units has gone steadily forward for the past decade. The first engine of this class was that exhibited by the John Cockerel Company at the Paris Exposition in 1900. This was an engine of 600 h.p. rating. At the present time 1500 h.p. in each cylinder of the four stroke cycle type and 2000 h.p. in each cylinder of the two stroke cycle engine are reported as one of the exhibits at the recent exposition at Brussels. This means units of 8000 h.p. of the twin tandem double-acting type. The present status of the large blast furnace gas power plants has been ably and thoroughly presented at recent meetings of this Section, and the papers and discussions form a valuable portion of the proceedings of the Society.

It is understood that at least one company is prepared to install gas engine plants of large power capacity at a cost not exceeding and in some instances less than that of the corresponding steam turbine installations.

The Diesel Engine.

Although the steam turbine has superseded the reciprocating steam engine for electrical development in central station work, and will probably hold the field for some time to come, it is interesting to note that the Diesel engine, owing to its great success in small station service, is looked upon seriously as a possible rival to the steam turbine within a short time. In a paper recently presented before the Municipal Electrical Association at Brighton, England, the relative cost of a 10,000 kw. installation for steam turbines, gas producers and engines, and Diesel engines, was discussed at length. The author's proposition was to use seven sets each of 1450 kw. capacity. His figures of operating expense, etc., are decidedly in favor of the Diesel engine installation.

Attention was also called to the economical use of these engines as a substitute for substation converting machinery. Such stations are already putting in their appearance in London.

In this connection it is interesting to note the development in point of size of the Diesel engine. Engines of a few hundred horsepower have become common in European practice. In Swiss electric stations Diesel engine units of 2000 h.p. are now in use, and one writer on the subject states that the development

[1]Paper delivered before the Gas Power Section of the American Society of Mechanical Engineers, New York, December 4 to 9, 1911.

of the large sized Diesel engine has been so successful that it will not be long before 1000 h.p. developed in one cylinder will be thought nothing extraordinary. One company of world-wide reputation is at present considering more than 200 h.p. in the single cylinder of Diesel engines. It is stated that engines of this type with four cylinders developing 1000 h.p. each can be made as light as the corresponding triple expansion engine.

The weight of such engines compares favorably with that of the corresponding turbines and boilers. It is understood that a 1000 h.p. installation of this type weighed only 187 lb. per h.p. as compared with 180 lb. for a steam turbine and boiler installation.

The crude oil engine is now definitely under consideration for all types of marine craft. For small vessels the advantage lies in the safety afforded by the use of crude oil as compared with the lighter oils. The crude oil engine is being used by many of the principal navies of the world for submarine boats and designs are already under way for comparatively large engines for torpedo boats and similar craft.

A few months since, the Vulcanus, a vessel of 1900 tons displacement, 196 ft. long, equipped with six cylinder four cycle single-acting reversible Diesel engines, was put in regular service between Holland and Borneo. This engine is about 500 b.h.p. capacity at 180 r.p.m. The fuel is a crude oil from Borneo and the quoted guarantees are 0.42 lb. per b.h.p. hour at full speed; 0.44 lb. at three-quarters speed; and 0.5 lb. at half speed. In a recent trip the Vulcanus covered 3312 miles in 19 days and 3 hours. The average speeds varied from 6.86 knots to 7.80. It is understood that the average consumption for this ship amounts to one ton of fuel oil per 100 knots.

The technical journals of recent date record many such installations. Among these Russia is credited with at least four freight vessels of 1000 h.p. and two 14 knot gun boats of the same horsepower rating. This month two vessels nearly 400 feet long of 7000 tons capacity each fitted with Diesel engines of 2500 h.p. rating, and with two auxiliary Diesel engines aggregating 500 h.p. will be tried out in European waters. A recent announcement is to the effect that the Hamburg-American Company proposes to build an ocean liner using Diesel oil engines for motive power.

An interesting comparison will shortly be placed before the public by the British admirality, as it is proposed to try out side by side in a twin screw a steam engine and a Diesel engine of 6000 h.p. rating. Another destroyer recently ordered by the British Admiralty, according to current reports, will have on each shaft a steam turbine and a Diesel engine. The plan is to operate the turbines when high speeds are required, but under cruising conditions, when the speeds are low, owing to the poor economy of the steam turbines, the Diesel engines will be used. The combined economy due to this arrangement will be exceedingly interesting.

One of the interesting features of these engines is the fact that there seems to be a marked tendency toward the two cycle for marine work. With the introduction of these engines the discomforts of the stoke hole will be greatly reduced and the amount of labor required will be less than under present marine conditions and the character of labor much improved. Although not probable that steam installations are to be rapidly displaced in the larger ocean-going craft, yet the crude oil engine seems to be especially adapted for such service as that previously indicated. The fuel needed approximates a third of that needed for the steam engine, thus greatly increasing the radius of action if the same weight of fuel be carried. Boilers can be done away with and their space utilized for carrying cargo.

It is reported for a freight vessel of 2700 tons that a saving of over $19.00 per day was made by using oil at approximately $11.00 per ton, instead of coal at about $3.00 per ton.

Tar as a Fuel for Diesel Engines.

Tar oil has become more or less common as a fuel for Diesel engines of 600 or 800 h.p. rating and it is understood that it is used in at least one engine of 4000 h.p. rating. Recent experiments indicate that both thin gas retort tar and thick coke oven tar can be used in a similar manner by injecting into the cylinder a small percentage of light oil to assist in igniting the tar. It is claimed that a wide range of tars can be used in this way.

Utilization of the Waste Heat of the Gas Engine.

Various methods of utilizing the waste heat of the gas engine exhaust have been attempted from time to time and the demand for such devices for heating buildings has been considerable. Several schemes for accomplishing this result are now commercially in use, but according to recent opinions the most efficient method of utilizing the exhaust is through a combination of gas and steam engines. Present practice indicates that about three pounds of steam are generated per b.h.p. hour by means of exhaust boilers.

According to Mr. Chorlton the use of exhaust boilers with efficient steam engines and specially designed gas engines of the two-cycle type will effect marked thermal economics and reduced initial cost of the installation per horsepower. One of the technical journals states that Mr. Chorlton shows by numerical examples the possibilities of such an engine, first examining the case of the addition of a steam end to a normal economical gas engine. He assumes a standard engine to use 9500 B.t.u. per b.h.p hour. As the engine is ordinarily arranged with jacket feed to the boilers we may take 40 per cent of this amount to be recoverable. From this at 80 per cent efficiency of conversion at 100 lb. pressure we would recover about 2½ lb. of steam per b.h.p. hour. This amount in an ordinary simple steam engine would not give more than 10 to 12 per cent of the main engine power, a return which hardly justifies the first cost of the steam cylinder. Consequently no development has taken place in this direction.

When, however, we are dealing with a special combined compound engine, each part of which is made in the most suitable way for the purpose required, we get a very different result. In order to reduce the cost of the gas engine part the compression would be lowered and with the ignition retarded a much lower maximum pressure and temperature would result; the total heat units used would go up to, say

12,000 B.t.u. but more would be rejected to the exhaust, and with a special arrangement of boiler, economizer pipes, superheaters in exhaust, etc., 50 per cent waste heat should be recoverable. There should be obtained from this 4 lb. of steam per b.h.p. hour.

The steam cylinder used would be similar in type to that of the two-cycle engine—that is, with no exhaust valves. The unidirectional-flow engine of this type has been largely reintroduced in Germany with very economical results. The jacketing of the ends could be done by exhaust gas. For small engines of this type it is safe to assume a steam consumption of 12 lb. per b.h.p. hour; a consumption of 10 lb. has been obtained in actual practice. Hence the power obtained from the steam cylinder would be one-third of that of the gas cylinder, and the consumption for total effective power would be reduced to 9000 B.t.u. per hour, less than that for the economical gas engine alone.

Surface Combination.

By what he terms "surface combustion" Professor Bone reports for gas fired boilers evaporations of 21.6 pounds per square foot of heating surface and an efficiency of heat transmission of 94 per cent. The heat balance of a test reported by him shows:

Gas burned per hour (at 32 F. and 14.7 lbs.)	997 cu. ft.
Net calorific value of gas	562 B.t.u.
Total heat supply to boiler per hour	559,800 B.t.u.
Temperature of feed-water	42 F.
Pressure of steam	100 lbs.
Water evaporated per hour	450.3 lbs.
Water evaporated from and at 212 F.	550 lbs.
Heat transmitted to water 450.3 × 1172 =	527,800 B.t.u.
Heat ratio 527,800 + 559,800	.943

In the reports of the surprising results of these investigations, attention is called to the fact that the combustion was perfect as was shown by analysis. An efficiency of 94 per cent was obtained. Deducting 4 per cent for the power required for supplying air pressure still leaves 90 per cent.

Professor Bone says, "The new boilers could be set up in brick work and require no elaborate flues or chimneys. They are liable to no strains as they are short. With some sacrifice of efficiency the evaporation could be raised to 30 lb. per sq. ft. The steam was raised quickly (steam at 100 lbs. pressure obtained in 20 minutes from cold start) and tubes could be grouped and cut out separately so as to vary the fuel consumption to suit the fluctuations of load." Sixty-five per cent of the steam was generated in the first foot of the tubes; 25 per cent in the second foot, 10 per cent in third.

Producer Gas from Low Grade Fuels.

Progress is steadily being made in the utilization of lignite, peat, and high ash coals in producer gas work. The investigations of the Canadian Government show that peat can be prepared for fuel purposes at a cost averaging from 30 to 40 per cent of that of an equivalent B.t.u. value in anthracite in Canada.

As the foundation of a method that may result in extensive use of high ash fuels without prohibitive cost of operation, attention is directed to the present producer-gas investigations of the United States Bureau of Mines, resulting in the successful fusing of the ash and the use of water-cooled producer linings.

In line with this specific conservation of fuel resources it is interesting to note that one estimate states that the U. S. Steel Corporation alone, through its installations of blast furnace gas engines, displaces, or saves, a consumption of approximately a million tons of coal per annum as against the old fashioned methods.

Small Producers for Bituminous Coal.

Reports are persistently before us indicating the successful development of gas producers of small power to operate on bituminous coal, coke breeze, anthracite screenings, "front and cinders," etc.

Such plants are in great demand, but it is doubtful whether the development and application have been as great as the advertising these plants receive. It is interesting to record, however, that a company, manufacturing anthracite gas producers and gas engines, that expressed in 1904 its firm conviction that the Government tests with bituminous coal in producers would fail utterly, recently put itself on record as recommending the use of its own engines with small bituminous producers manufactured by another company.

Crude Oil Gas Producers.

The development of the crude oil gas producer for which there is great demand, in oil regions remote from the coal field, has been exceedingly slow but it is believed that definite progress has recently been made along this line. The most recent notes on this subject relate to the Grine oil producer. In this type steam spray is used for atomizing the oil which is introduced into the upper part of the generator where partial combustion takes place. The downdraft principle is then applied and the hydrocarbon broken up and the tar fixed by passing through a bed of incandescent coke. Mr. Grine reports that a power plant using one of these producers has been in operation a year in California. With crude oil as a fuel costing 95 cents per barrel, or 2.3 cents per gallon, the plant is reported to develop the same amount of power per gallon of crude as is ordinarily developed by the standard internal combustion engine operating on distillates at 7 cents per gallon. Including the cost of fuel, labor, supplies, interest, depreciation and taxes, Mr. Grine states the cost per b.h.p. hour to be 0.76 cents for a plant of 100 h.p. rating

Conclusion.

It is gratifying to note that each year eliminates many of the absurd prophecies regarding the elimination of practically all prime movers have the internal combustion engine and that the past year may be regarded as one of steady, conservative progress and development in the field that is of such keen interest to so large a percentage of the total membership of the American Society of Mechanical Engineers.

COLTANO WIRELESS TELEGRAPH STATION.

The most powerful wireless telegraph station yet constructed has just been completed at Coltano in Italy, under the direction of Mr. Marconi. With an available power of 1000 kilowatts and an aerial 1200 meters long, it will enable Italy to conduct a wireless telegraph service with countries situated at a distance of several thousand miles.

OIL BURNING.

BY E. N. PERCY.

(Continued.)

Locomotive boilers are arranged for oil firing to meet two sets of conditions: First, that type of locomotive boiler that is used for stationary or steamboat work, and has only a mild draft; second, that type of locomotive boiler that is used for actual locomotive work and works with a heavy fire under the most powerful draft conditions.

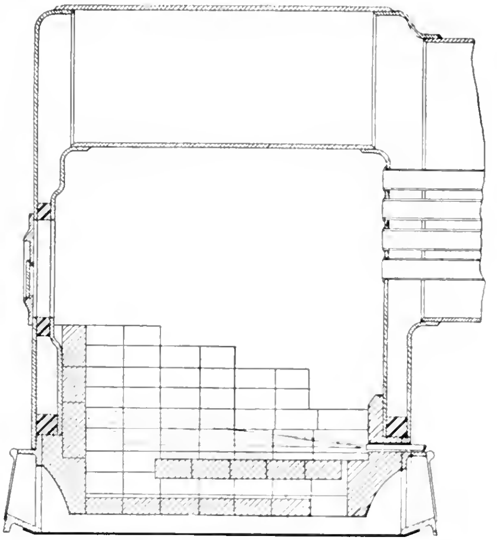


Fig. 34. Heavy Draft Locomotive Boiler.

Fig. 34 shows a locomotive boiler arranged for burning oil under a heavy draft.

Fig. 35 shows an arrangement of a locomotive boiler for burning oil with a comparatively mild draft.

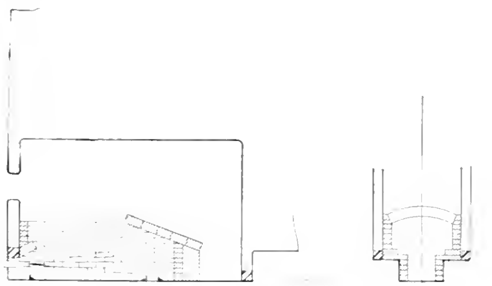


Fig. 36. Heavy Draft Locomotive Boiler.

Fig. 36 shows locomotive boiler fired from the front of the boiler. This practice is now almost obsolete, it having been found better to fire a locomotive boiler from the back end because if fired from the front it has been found that the flame tends to impinge upon the tube sheet, over-heating same, or, if a protection wall of brick be erected it impinges upon this wall after the form of the now obsolete target system of burning oil, and the efficiency is reduced accordingly.

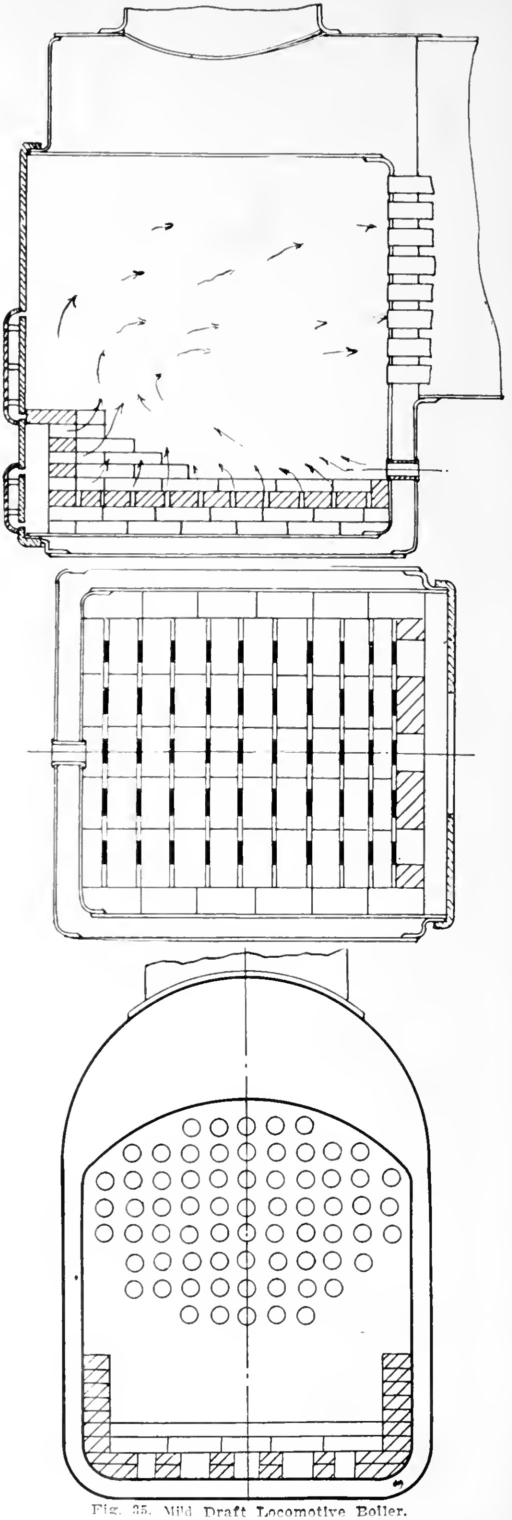


Fig. 35. Mild Draft Locomotive Boiler.

Fig. 37 illustrates a method of rigging up boilers on small locomotives such as ordinary engines, con-

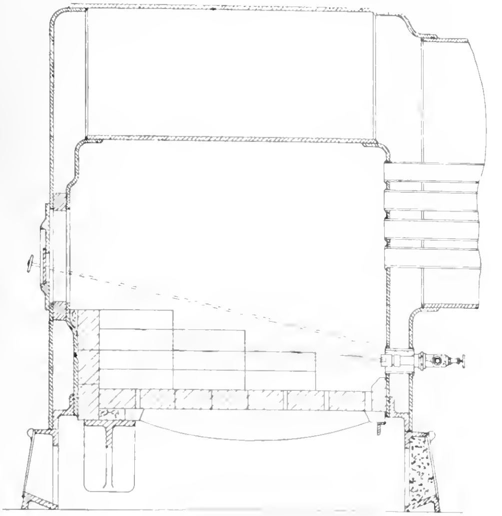


Fig. 37. Locomotive Boiler for Heavy Draft.

tractors' outfits, etc., which has been found satisfactory.

Fig. 38 shows a method of fitting up a donkey boiler for oil burning. As special brick are not always procurable for this purpose they may be chopped from ordinary wedge brick, or the entire protection may be moulded from fire clay protected with sheet iron.

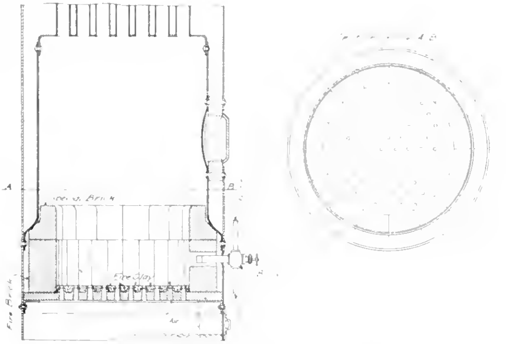


Fig. 38. Arrangement of Donkey Boiler for Oil Burning.

The sheet iron soon burns away, baking the fire clay while doing so, after which the fire clay vitrifies, forming a compact and protective lining for the lower part of the boiler.

Fig. 39 illustrates the arrangement of a drop tube steam launch boiler for oil burning. This particular arrangement has been found very satisfactory in practice.

Fig. 40 shows the basic principles of arranging a Scotch boiler for oil burning; either the round flame or flat flame system may be used. If the flat flame is used the draft must come from below the flame and

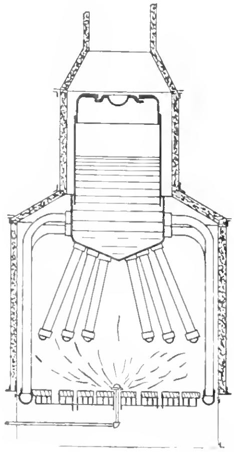


Fig. 39. Ward Navy Launch Boiler Fitted With Oil Burner.

through it by means of brick properly arranged as shown just below the flat flame. If a round flame is used the draft must be admitted through annular ports surrounding the oil burner. It should be remembered in dealing with horizontal conical flames that they do not assume the nice symmetrical forms shown on drawings. Instead of this they tend in a general way to rise because of the heat and distort accordingly, and the cold air tends to sink and flow below the flame, leaving the top of the flame somewhat smoky. These conditions must be compensated for

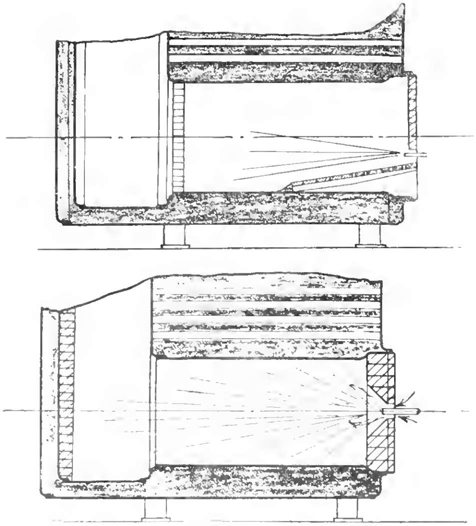


Fig. 40. Internally Fired Boiler.

by a proper adjustment of the draft. Scotch boilers have been subject to very special treatment and equipped with highly specialized systems of oil burning that may differ in some respects from ordinary practice because of their peculiar requirements.

Burners.

While the usual method of burning oil has presupposed its atomization with steam many other systems have developed. It would be difficult to classify them in any logical manner, hence, they are simply listed as follows: First, atomization with air at 20 to 100 pounds pressure used for marine installations to economize fresh water, and in metallurgical furnaces where steam might have a deleterious effect upon the products; second, low pressure air in which air from 2 oz. to 2 lb. is used as an atomizing agent. This is the system usually implied for all industrial work requiring large heavy fires, such as cement kilns, lime kilns, brick pottery and terra-cotta kilns, forges, reverberatory furnaces, glass works, etc. Some of the exceptions might be mentioned, such as the American-Hawaiian Steamship Company's boats, which are equipped with low pressure air oil-burning outfits, and a few of the glass furnaces and pottery kilns, which are equipped with special types of steam burners; third, various mechanical systems in which the oil is atomized by the application of energy in some other form than compressed air or steam. This type of burner as developed by various manufacturers is being installed in a great many ocean-going steamers because of the aforesaid necessity of economizing fresh water.

Besides these systems of oil burning which are in very general use and have been proven by experience to be suited for proper sets of conditions, a number of burners are being developed upon entirely new principles, which have not as yet come into general use; they include, first, vaporizing burners. This type of burner is very old, and in fact exemplifies one of the earliest attempts at oil burning, and thousands of patents have been taken out on vaporizing burners, but the character of oil is such that it cannot be vaporized without leaving a residue, and this has caused the failure of vaporizing burners to come into general use. However, with the development of the oil industry distillates have become available, which have been removed from the residue and can be burned in vaporizing burners, but on account of their cost are adapted to stoves and small fires only. Second, the water burner in which oil and water are dropped on to a hot plate together, resulting in the formation of a froth and frying, which atomizes the oil very thoroughly and burns with a hot clear flame under proper conditions. We should mention here that which is known by every business man and few mechanics: that the success of an oil burner or any other invention depends ninety per cent upon the business ability and common sense used in its development, and ten per cent upon the actual value of the invention itself. Many other principles have been made use of in connection with the burning of oil, but they are not at this time in general use. The industry as a whole is in need of more rational development and less invention.

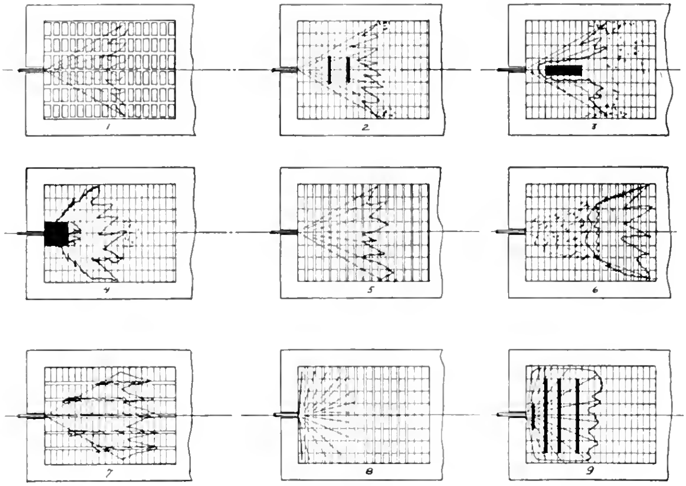


Fig. 41.

Fig. 41 illustrates the proper trimming of a flat flame and arranging of the bricks. Plate 1 shows a fan-shaped flame with openings between all of the bricks. The flame does not cover the bricks, therefore, no matter what the conditions are, there will be an excess of air and the boiler cannot work economically since it costs as much to heat air as it does to heat water. Plate 2 shows two large openings under the middle of the flame; such a flame will burn very hot in the center and deposit carbon in the corners as shown. Plate 3 shows one very large opening under the flame; such an arrangement will cause the flame to tear and burn intensely around the center while depositing carbon around the corners, as well as allowing cold air to rise and strike the boiler directly. Plate 4 shows a very large opening under the route of the flame; large quantities of air will escape over the flame; it will burn with intense combustion close to the burner, over-heating same, the flame will be irregular and ragged and smoke and deposit carbon at the tips. Plate 5 has transverse openings between

all of the bricks, allowing great access of air at all times. Plate 6 has no draft orifices in the neighborhood of the burner; such a flame will burn clear at the tips, but smoke and deposit carbon near the burner. Plate 7 illustrates that longitudinal slots tend to tear the flame. Plate 8, while having a broader, more correctly shaped flame, will have excess air and even cold air going up against the boiler, because the draft slots extend beyond the end of the flame. Plate 9 shows the correct arrangement of bricks and correct shape of flame for a flat flame furnace; air coming through the slots as shown.

Before discussing actual burners it may be wiser to refer to the principles which apply to all of them.

Figs. 42, 43 and 44 illustrate principles under which any atomizing type of burner will be classified. The drooling burner allows the oil to drool from an upper opening down to a lower opening from which the steam is issuing; an atomizer burner allows the oil to drop directly on the steam. The chamber or inside mix burner atomizes the oil within the burner after which it issues from an orifice of the desired form. An injector burner is designed primarily to operate without a pump, it being expected to suck the oil from the reservoir by the siphoning or injector-like action of the steam jet inside. In projector burners the steam blows the oil off the tip of the burner. A fan tail burner is any type of burner giving a flat flame. Rose burners give a circular flame and are used in any sort of circular furnace such as a donkey boiler or launch boiler. A long slot burner is apt to give a narrow flame. The fault with most engineers starting in with a flat flame burner is that their flame is too narrow, the burner not being trimmed to give a flame well back in the furnace with shutters at right angles to the burner and well back against the furnace front.

Some of the simplest and earliest burners in use for burning extremely heavy oils are shown in Fig. 45.

Figs. 46-64 are all round flame burners, the design of which is apparent upon inspection.

Figs. 65-79 are all fish-tail burners.

Fig. 80 is a combination specially designed to be used in conjunction with a simultaneous burning of sawdust and fuel oil, the idea being that when the oil furnace is not in use the fire brick screen is dropped in order to protect the burner and shutters from the intense heat radiated from the interior of the furnace. Note the rotary shutter for regulating the draft and hand wheel on same.

Fig. 81 shows the Fess system rotary burner, which is operated by a small electric motor of 1/4 to 1/3 h.p. The motor operates by worm gear, a rotary pump, which brings the crude oil from the storage tank and applies it to the burner, which is placed in

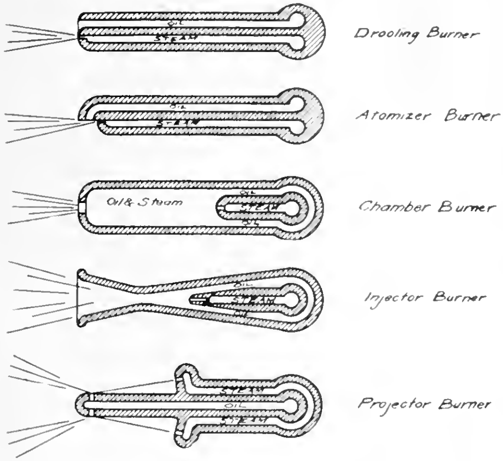


Fig. 42. Oil Burner Classification.

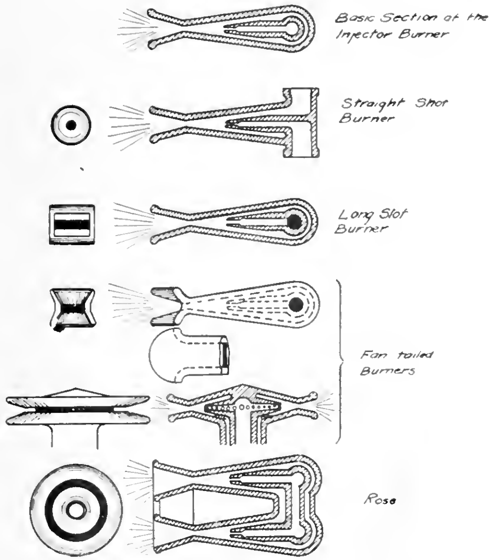


Fig. 43. Possible Modifications of the Injector Burner.

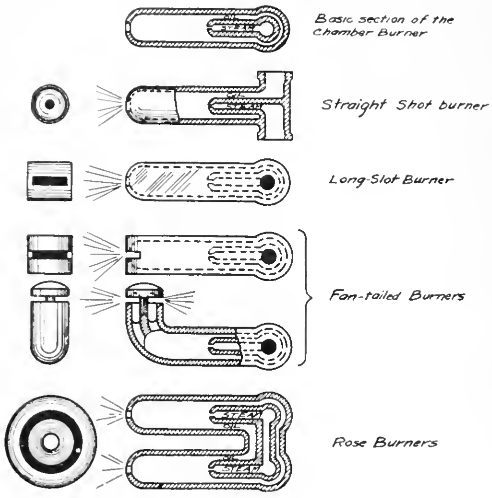


Fig. 44. Possible Modifications of the Chamber Burner.

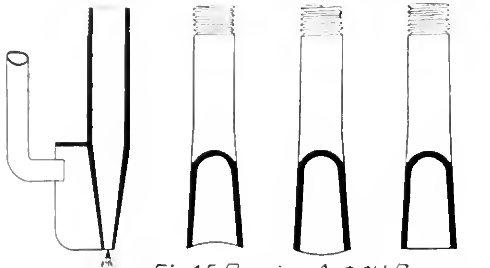


Fig. 45. Russian Astatki Burner.

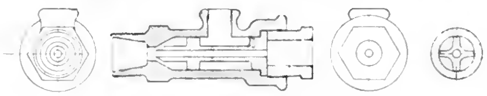


Fig. 46. Selby Burner.

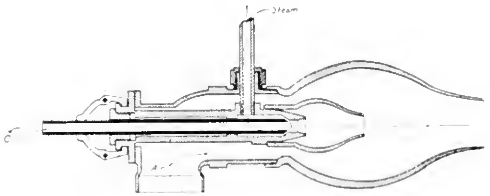


Fig. 47. Low Pressure Air and Steam Burner.

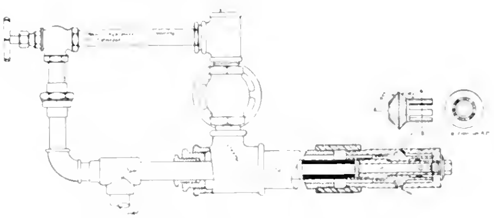


Fig. 48. McDonald Flue Oil Burner.

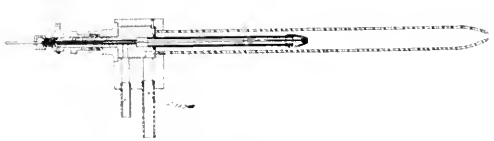


Fig. 49. Hayes Oil Burner.

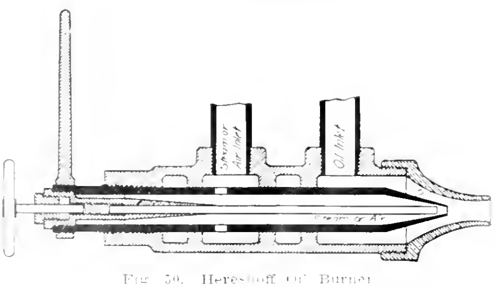


Fig. 50. Herreshoff Oil Burner.

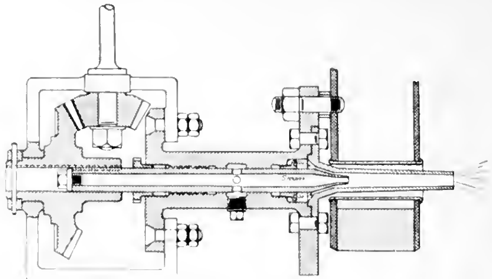


Fig. 51. Fuel Oil Burner. Pennsylvania Railroad.

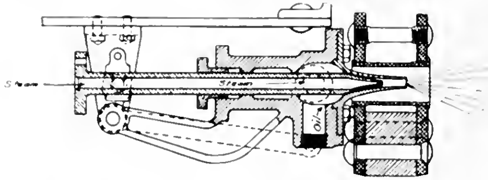


Fig. 52. Russian Locomotive Burner (Ourgard).

Fig. 53. Advance Company Oil Burner.

Fig. 54. Self Cleaning Burner.

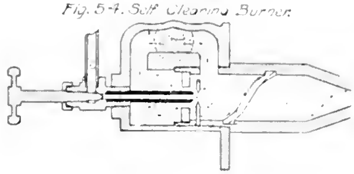


Fig. 55. Rotary Flame Burner.

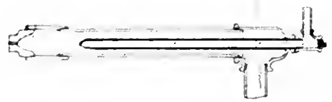


Fig. 56. Pipe Burner.

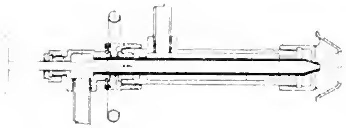


Fig. 57. Adjustable Tip Burner.

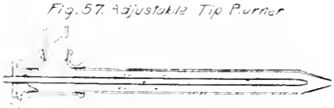


Fig. 58. Pipe Burner.

Fig. 59. Oil Burner Inside Mix. Pipe.

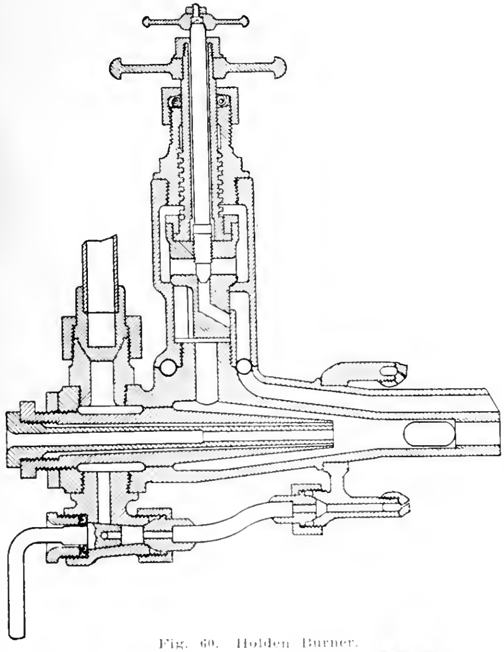


Fig. 60. Holden Burner.

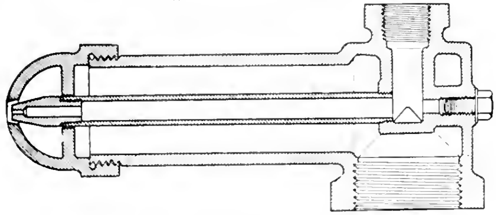


Fig. 61. Fitzsimmons Burner Low Pressure

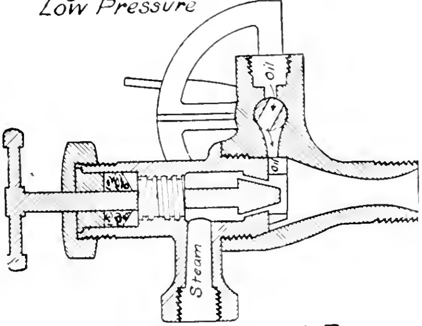


Fig. 62. Control Head Burner

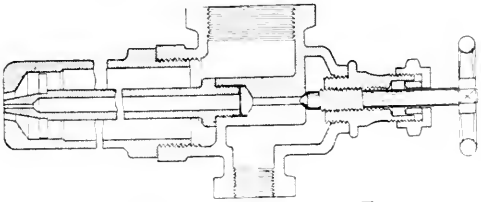


Fig. 63. Fitzsimmons Burner

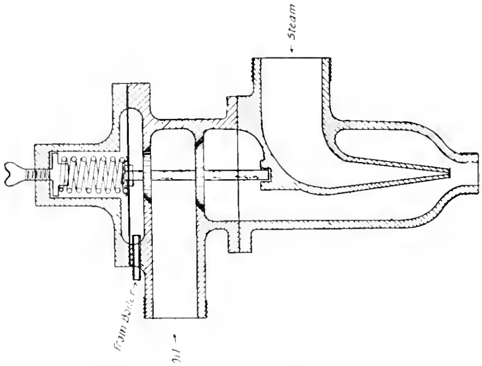


Fig. 64. Glafke Automatic Oil Burner.

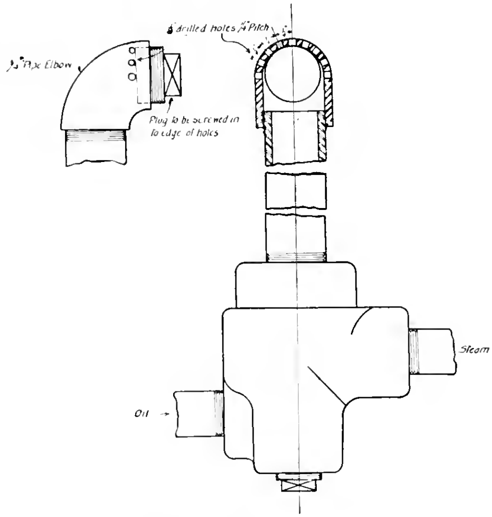


Fig. 65. Atomizer With Tip.

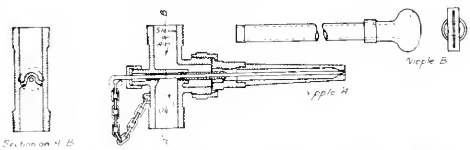


Fig. 66 "Hervey Process" Burner.

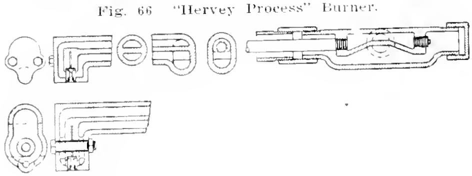


Fig. 67. Fitzsimmons Oil Burner.

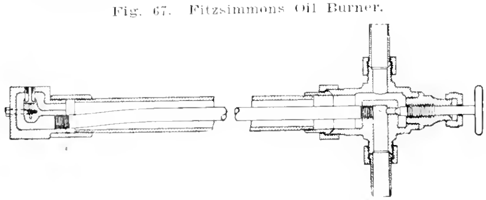


Fig. 73. Fitzsimmons Oil Burner.

Fig. 68. Staples & Pfeiffer Burner.

Fig. 69. Staples & Pfeiffer Burner.

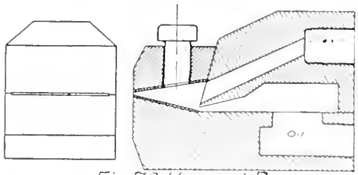


Fig. 70. Hammel Burner.

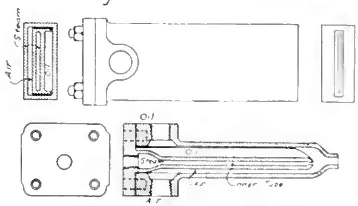


Fig. 71. Southern Pacific Burner.

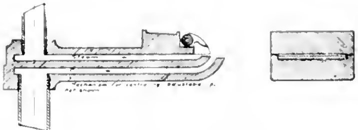


Fig. 72. Oil Burner used by Allis-Chamers

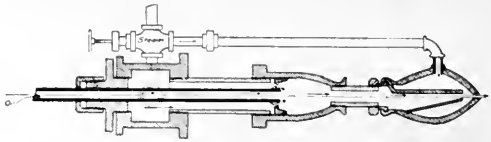


Fig. 74. Chamber-Mixing Burner

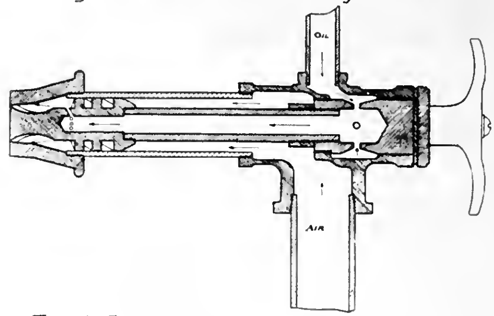


Fig. 75 Grundell-Tucker Oil Burner

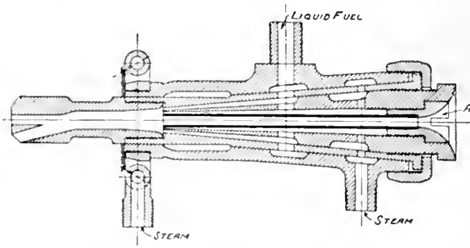


Fig. 76. Holden Burner

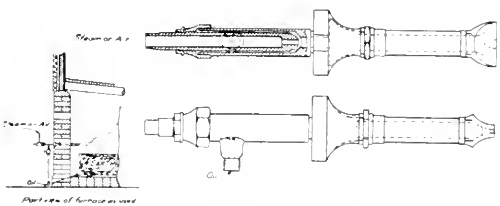


Fig. 77. "Branch" Oil Burner.

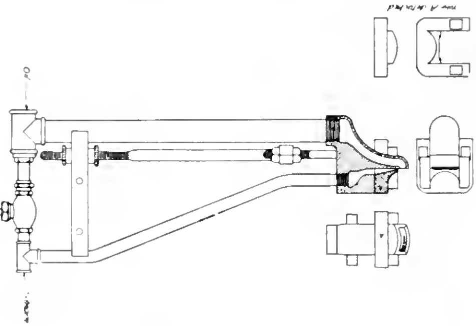


Fig. 79. W. N. Best Oil Burner.

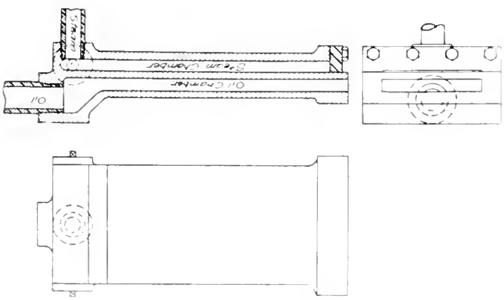


Fig. 78. "Santa Fe" Oil Burner.

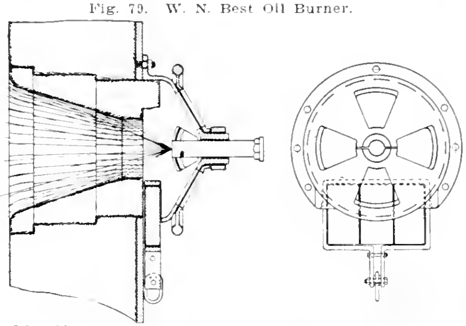


Fig. 80. Fitzsimmons Burner Arranged for Burning Sawdust and Oil.

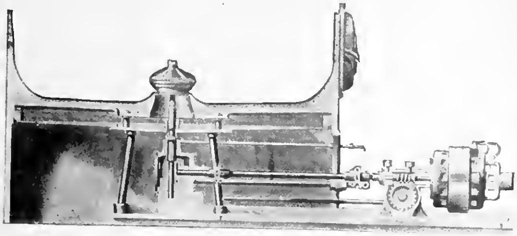


Fig. 81. Fess Rotary Burner.

the center of the firebox, and which rotates at a sufficient speed to thoroughly atomize the oil by centrifugal force with the necessary air to produce a smokeless flame equally distributed throughout the firebox.

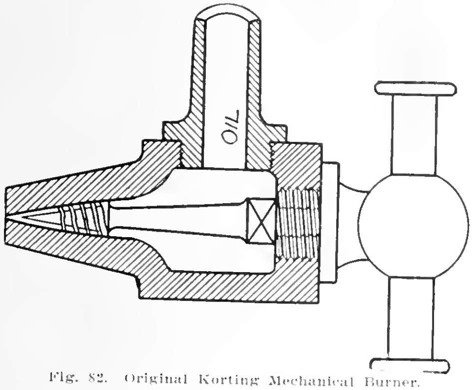


Fig. 82. Original Korting Mechanical Burner.

Taking up the subject of mechanical burners we find: first, in Fig. 82, the Korting, in which the oil is atomized partly by the application of great heat in carefully constructed heaters, and partly by the action of centrifugal force within the burner. These burners are usually installed in duplicate in a carefully constructed furnace front.

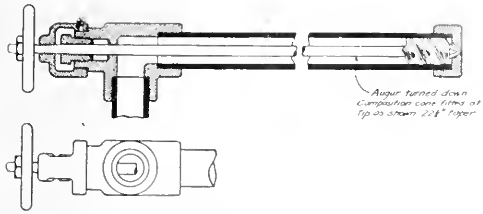


Fig. 83. Naval Fuel Oil Board Burner.

Fig. 83 is a type invented and proposed by the Naval Fuel Oil Board after considerable experiment with all kinds of burners.

Fig. 84 illustrates the principle involved in a centrifugal type of burner.

Fig. 85 illustrates the mechanical burner used in the Baku oil fields, Russia.

Fig. 86 illustrates clearly the arrangement of the furnace in a Scotch boiler used on the Steamer "Brouwer," using the mechanical spray burner.

Fig. 87 shows the arrangement of the furnace on the Steamer "Tebe" using mechanical spray burners.

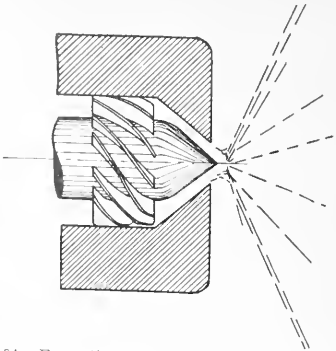


Fig. 84. Formation of a Mechanical Spray Under Joint Action of Pump Pressure on Oil and Centrifugal Action of Screw Guide Blades.

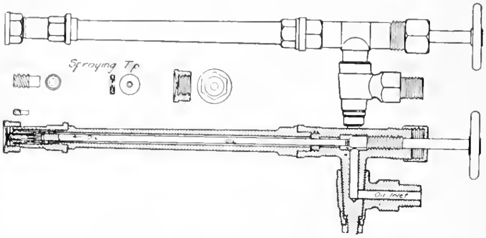


Fig. 85. Mechanical Burner Used in Baku Oil Fields of Russia.

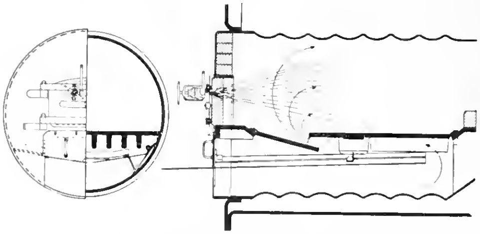


Fig. 86. Furnace Arrangement on "Brouwer" Using Mechanical Spray Burners.

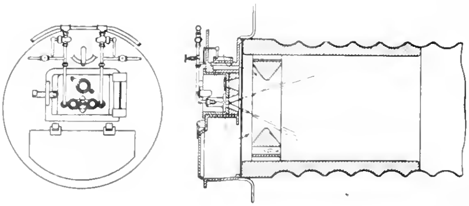


Fig. 87. Furnace Arrangement on "Tebe" Using Mechanical Spray Burners.

Fig. 88 shows a burner which was designed, built and experimented with by the writer, the principle being altogether different from those previously shown. The oil was lead in radially converging lines at increasing velocity along a thin disk and forced through a small hole in the center of this disk. The burner while technically a success was practically a failure because it could not be kept in operating condition. The heat

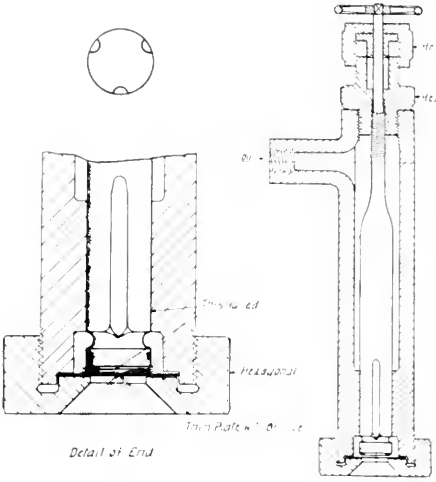


Fig. 88. Mechanical Soft-Atomizing Burner.

distorted the thin disk and the velocity of the oil scarred the accurately finished surface of the adjusting plug until the flame lost all geometrical shape.

Various moving devices have been invented for the purpose of atomizing oil. Fig. 89 illustrates one

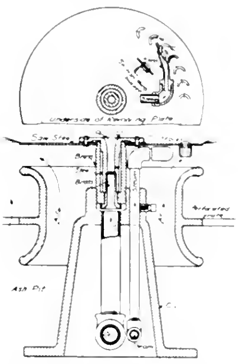


Fig. 89. Williams Centrifugal Burner, Solid Pivot

designed for circular furnaces to operate in a horizontal position. It may be driven either by steam turban as shown or by an electric motor. A great many of this type are now in operation, electric driven, in apartment houses and large homes where no steam pressure is available. Fig. 90 shows another type of steam driven turbine burner intended to operate in horizontal position. The experiments that have been made in the burning of fuel oil are almost without number and upwards of twenty-seven thousand patents have been taken out in the United States patent office.

A most excellent oil burning system has been developed in our midst by the engineers of the Union Iron Works and is at present installed on about a dozen steamers and being installed on as many more. It is of the mechanical type operating on the centrifu-

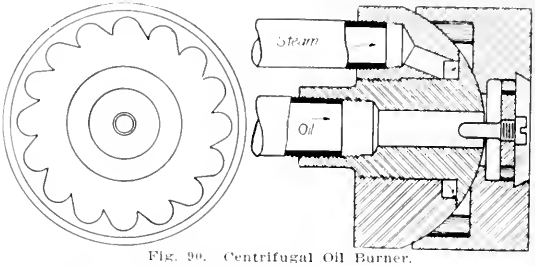


Fig. 90. Centrifugal Oil Burner.

gal principle in combination with the thorough heating of the oil. Fig. 91 illustrates the general arrangement of the system.

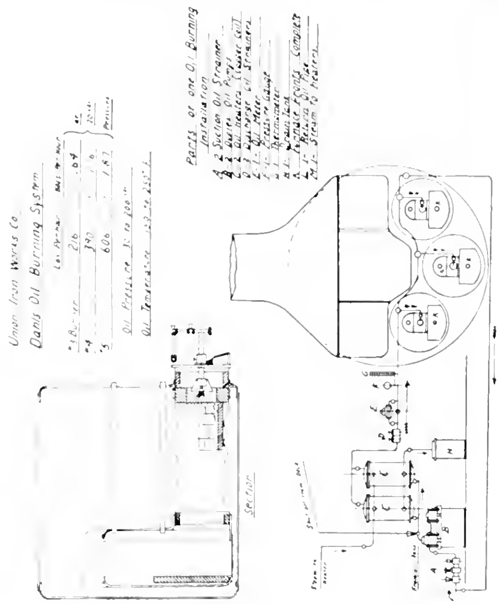


Fig. 91.

The installation of an oil burning plant is apt to suffer from one of two evils: either the parties responsible for the installation are of the impression that almost any way of squirting oil into the furnace will result fairly well; or the attempt is made to construct an ideal plant with an excessive amount of complicated apparatus. By following the general directions outlined in the preceding columns there is no reason why any good practical engineer cannot successfully install an oil burning plant. Remember:

First, all air should go through the flame.

Second, the flame works best when near hot brick.

Third, the flame should not impinge upon anything.

Fourth, the oil should be heated in a reservoir and in a heater from beginning to end and delivered to the burners at the highest temperature practicable.

Last, but not least, get good oil under a good contract from a good company that will deliver it no matter what the exigencies of the oil business may be.

(To be Continued)

FRANCIS TURBINES.

Discussion by members of the San Francisco Section of the A. I. E. E. December 1, 1911, of paper on "The Reconstruction of a 20,000 h.p. Hydroelectric Power Plant," by Geo. J. Henry, Jr., and J. H. Hansen, published in this Journal, November 25, 1911.

The meeting was called to order by Professor S. B. Charters as chairman, with an attendance of over sixty. Mr. J. H. Hansen read the paper and stated that the formula for the specific speed as published was an error and should read

$$N_s = \frac{N\sqrt{h.p.}}{H\sqrt[4]{H}} = 63.5.$$

After the paper had been read the chairman stated that it was open for discussion.

J. P. Jollyman asked information as to the closing time adopted and also as to the pressure rise.

J. H. Hansen stated that three seconds' time elapsed in closing the gates and that while no record had been kept of the pressure rise relief valves acted at no time and consequently the pressure rise never reached a dangerous point. This being due to the very short pipeline.

Ralph Bennett inquired as to speed regulation.

J. H. Hansen stated that this likewise did not exceed any extreme limit. The turbines are running at constant load and all of the sudden load changes are taken care of at the company's steam plant at Redondo.

H. Homberger then read the following discussion:

The paper we just have heard is particularly interesting because it deals with the often discussed question whether in a particular hydroelectric power plant under what has been called a "medium head" turbines or impulse wheels should be installed to give best results.

The plant referred to has quite a history, and on account of this history and the many changes that have taken place there during the past years, has been watched with keen interest by everybody engaged in hydroelectric power plant work.

The specific speed for the turbines had to be made extremely low to meet the running speed of the generators already installed, and no matter what the initial efficiency of such a turbine may be, the average efficiency during the life of one set of wicket gates and one runner, notwithstanding protection plates, is bound to be considerably lower than the initial efficiency, due to the rapid wear to be expected in these parts with the consequent heavy hydraulic losses. Heavy maintenance expense and shut-downs for repairs [illegible] may be unavoidable under the stated conditions [illegible] a Francis turbine as well, probably more so than with an impulse-wheel of an admittedly lower initial efficiency.

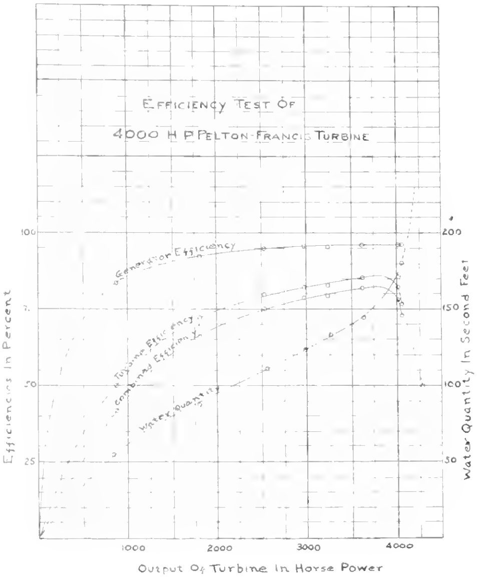
In order to arrive at any conclusion regarding the [illegible] commercial efficiency of the turbine referred to in the paper, it would be necessary to repeat the efficiency test [illegible] intervals of, say, six months. This would also give [illegible] ance to the owner of the machine when it would [illegible] investment to replace the worn buckets and runner [illegible] ones.

In this particular plant, for best results the turning [illegible] of the generators is too low for a Francis turbine of [illegible] nary type and too high for an impulse wheel.

To govern such turbines without the aid of relief [illegible] and surge-chamber by means of a slow acting governor [illegible] ply means to give up satisfactory regulation. This [illegible] missible only when the plant is one of a number [illegible] into one transmission system, where close regulation [illegible] accomplished at some other well-designed plant. No satisfactory regulation is possible with so high a velocity [illegible] in the pipe.

To be quite sure of a constant load on a generator under test it should be loaded by a water-rheostat and absolutely disconnected from the power system. Any other method is open to the criticism that errors are almost unavoidable.

The efficiency curve shown in the paper was plotted with reference to gate-openings in inches; the user of the turbine is not interested in the degree of gate opening, but in the amount of water consumed for the corresponding power output. The efficiency curve which I have plotted with the power output as abscissae gives a curve not nearly as ideal as the one shown in the paper.



The prime-mover should be capable of carrying an overload on the generator of at least 25 per cent, which in this case would be 3290 kw. with an assumed efficiency of the generator of 95 per cent at that load. The test does not show what the efficiency of the turbine would be under that load, the dotted continuation of my efficiency curve, however, indicates it.

The generators are called 2500 kw. machines, but I understand that they were sold for 2000 kw. units. The power company operates these machines under a constant load of about 2500 kw. each, so that the turbine actually operates under a load which gives the peak of the efficiency curve.

When the first Borel turbine was finished and erected in the shop of the Pelton Water Wheel Company I had an opportunity to see it and was most favorably impressed by design and workmanship. With exception of some minor details of design, which are probably to be attributed to the fact that it was a replacing job, that machine ranks with the very best I have seen.

J. P. Jollyman then told of the excellent results obtained with the Francis type of turbine at the Centerville plant of the Pacific Gas & Electric Company, which was operated at about the same low speed under a much higher head than the turbine at the Borel plant. He stated that the maintenance had been very low and that the efficiency even increased after some years' service.

A. C. Sprout asked as to where the line should be drawn between advisability of using impulse and turbine type of wheel.

J. H. Hansen answered this question by reading the following explanation and discussion on specific speed.

Classification of Francis Turbines.

In the clasification of Francis turbines, and water wheels in general, specific speed or type characteristic is most commonly used. It is mathematically expressed

$$N_s = \frac{N\sqrt{h.p.}}{H\sqrt[4]{H}}$$

This formula embraces the three governing factors for the type of any water wheel or turbine runner, viz: (N) the speed in revolutions per minute; (H) the effective head in feet, and (h.p.) the capacity in brake horsepower output.

It can be developed as follows: The water quantity Q which will flow through an orifice with an area of A square feet under an effective head H is:

$$Q = C_1 A V$$

where the velocity $V = \sqrt{2gH}$ and C_1 is a constant, according to the decrease of area due to the contraction of the stream of water.

We can therefore write: $Q = C_2 (A\sqrt{H})$ where $C_2 = C_1\sqrt{2g}$; i.e. the water quantity that flows through a certain opening is proportional to the area of the opening times the square root of the effective head.

The symbol $Q_1 = \frac{Q}{\sqrt{H}}$ represents the quantity of water which flows through an opening under the head equal 1 ft. Q_1 is therefore a constant for equal openings with the same co-efficients of friction and contraction; and the water quantity which flows through this opening at any head H is. $Q = Q_1\sqrt{H}$.

Q_1 we will call the "specific quantity" or the discharge constant. If the water is discharged through a turbine runner of a certain diameter D and width W the inlet area of

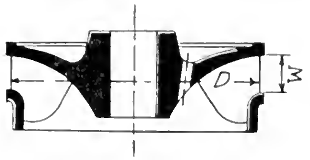


Fig. 1. Turbine Runner

the runner is $A = C_3 \pi D W$, where C_3 represents the decrease in area due to the thickness of the vanes. The width of the runner is always a certain proportion of the diameter, i.e

$$W = C_4 D$$
$$A = C_3 C_4 \pi D^2$$

Therefore: The quantity of water that will pass through this runner is $Q = A C_5 \sqrt{H}$; where $C_5\sqrt{H}$ is the velocity at the inlet.

It is therefore $Q = C_3 C_4 C_5 \pi D^2 \sqrt{H}$.

Or if we substitute another constant C_q instead of $C_3 C_4 C_5 \pi$

$$C_q = \frac{Q}{\sqrt{H}\,D^2} = \frac{Q_1}{D^2} \qquad (1)$$

On the basis of this formula we can compare different runners with reference to their capacity. C_q is a capacity constant which will have different values for different types of runners with the same diameter.

In this comparison another important factor comes in, viz: the speed. Two runners might have the same discharge capacity, but not the same speed or vice versa. In order to get a correct comparison, we must have a formula that contains both capacity and speed.

If the number of r.p.m. of a runner with inlet diameter D is N, then $N = \frac{V}{\pi D}$ where the circumferential velocity V of the runner is proportional to the square root of the effective head H; i.e. $V = C_6\sqrt{H}$.

From formula (1): $D = \frac{\sqrt{Q_1}}{\sqrt{C_q}}$

This gives $N = \frac{C_6\sqrt{H}\sqrt{C_q}}{\pi\sqrt{Q_1}}$

Or if we substitute $\frac{C_6\sqrt{C_q}}{\pi} = C$

Then $C = \frac{N\sqrt{Q_1}}{\sqrt{H}} = \frac{N\sqrt{Q}}{\sqrt{H}\sqrt[4]{H}}$

This formula contains both discharge capacity, speed and effective head. Instead of the discharge quantity Q, we can also substitute the number of horsepower by assuming a certain efficiency.

It is $Q = \frac{1}{.1134 \text{ eff}} \cdot \frac{h.p}{H}$

Or $\frac{C_s}{\frac{1}{.1134 \text{ eff.}}} \cdot \frac{N\sqrt{h.p.}}{H\sqrt[4]{H}} = N_s$

This new constant is the specific speed or the type characteristic of the runner.

$$N_s = \frac{N\sqrt{h.p.}}{H\sqrt[4]{H}} \qquad (2)$$

In figures it represents the speed of a runner, which if diminished to **one** foot diameter would develop **one** horsepower under **one** foot effective head.

In the modern turbine practice, this constant (N_s) varies from 10 to 80 (90) for single wheels. If the specific speed falls below 10, it means that an impulse wheel has to be made; and if N_s becomes more than 80 (90) a turbine with more than one runner will have to be made. Runners with specific speed in the neighborhood of 10 are commonly called the low speed type, and runners with a specific speed near 80 are of the high speed type, whereas a specific speed of about 40 indicates a normal speed runner.

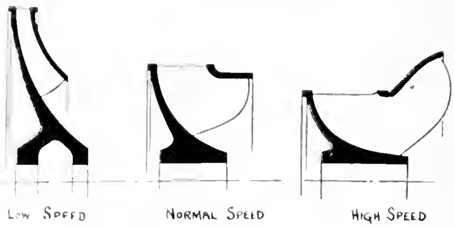


Fig. 2. Runners for Different Speeds.

As the shape of the runner varies with the specific speed, the efficiency of the runner will also be dependent upon this specific speed. A low speed runner has a large diameter and a very narrow throat, which in connection with high velocities (due to a high head) means greater friction losses and therefore a low efficiency. The higher speed runner has a wide throat compared with the inlet diameter ($W = \frac{1}{2}$ D) and as the outlet diameter is always greater than the inlet diameter the shape of the runner vane becomes very complicated. The efficiency of this runner vane will therefore not be as high as the normal speed runner ($N_s = 40$), where the inlet and outlet diameters are about equal.

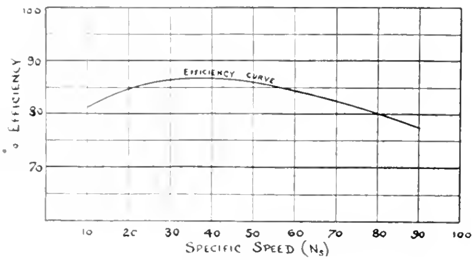


Fig. 3. Efficiency Curve of Runners Based Upon Specific Speed.

Fig. 3 shows an efficiency curve of runners based upon different specific speeds. This curve is meant to show only the relation between specific speed and efficiency of the runner. The maximum efficiency which can be attained by a turbine will also depend upon the type and size of the turbine. A 10,000 h.p. turbine, for instance, will give a higher efficiency than a 400 h.p. one operating under the same head and specific speed.

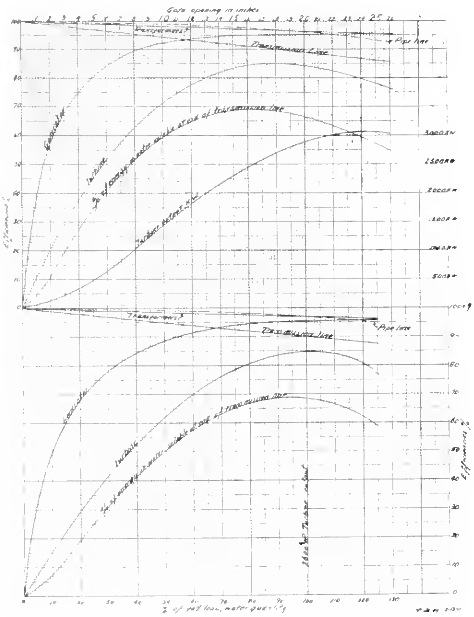
Geo. J. Henry in replying to Mr. Homberger's discussion, stated that the Borel installation was somewhat unusual in that it involved a very heavy investment in a canal twelve miles long, cement lined throughout as the result of a lawsuit in which plaintiffs claimed depreciation in water quantity would otherwise occur—the head is comparatively low for the Sierra Nevada mountain streams and the cross section of the canal quite large to give very low velocity—almost no storage exists at the intake.

The plant is run on feeders carrying also the Redlands steam plant which uses oil fuel at tidewater. And the results heretofore at Borel with the old Girard turbines were such that the cost per kilowatt produced on the large investment showed much to the disadvantage of the water pump plant, with its large first cost and unsatisfactory and expensive maintenance.

The installation of the Francis turbine, however, has increased the output from the water which the canal will carry (and this is the limiting factor in this station output and therefore of the return on the investment) by forty per cent. Or looking at it in another way. The unit of power produced cost only 70 per cent of and the power storage produced cost only 70 per cent of what it did formerly, and the more power developed at Borel the more oil saved at Redondo, because with a given water quantity flowing in the canal and Redondo taking the fluctuations oil is saved in the storage tanks and if the water quantity is less than the power demand at all times, which condition is approached in the water plants transmitting to the Los Angeles territory, we have a highly efficient power storage and the maximum returns from the hydroelectric plant investments.

When the question of designing efficient turbines or tangential wheels for the purpose of replacing the Girards first arose a preliminary study of the conditions involved showed the futility of attempting anything with any of the present well known tangential types of wheels, also the difficulty of meeting the low generator speed (no change being contemplated in the generators) with the Francis turbine. Mr. Hansen has pointed out the low specific speed in this instance—necessitating a larger, heavier and more expensive turbine unit than would be recommended for the same output today if the choice of speed was left to the turbine designer. The generators were re-rated. They were first 2000 kw. and the customer specified that they were run at 3000 h.p. output for the best turbine efficiency point, with 3600 h.p. output specified as the maximum. The first unit under test gave its highest efficiency somewhat above this point and on the remaining units this will be brought down to about the 3000 h.p. point. In regard to Mr. Homberger's statement that a prime mover should be capable of carrying an overload on the generator of at least 25 per cent. This statement in the abstract is undoubtedly true but it is also more literally true that the prime mover should be capable of delivering the full amount of mechanical energy to the generator that can be economically converted by the generator into electrical energy and no more. And in the concrete case before us the generators have been in use for years and their maximum efficient load has been definitely settled by the customers' engineers as 3600 h. p. and the load of maximum efficiency as 3000 h.p. These points are the limits for our design and must take precedence over the makers' original rating or for that matter the re-rating in such a concrete case because a thorough investigation of the operating machine and attendent apparatus has been conducted and the points of most useful and profitable turbine output definitely determined. The dropping off of the efficiency curve as given by Mr. Homberger beyond the 3600 h.p. point is therefore quite misleading as it goes entirely beyond the range for which the apparatus was designed of intended to be operated.

It is generally reported that the operation of this first unit has effected an economy of $2000 per month. I wish to elaborate a little more fully on Mr. Homberger's remarks regarding the value of efficiency. The entire investment in an hydroelectric plant is for the purpose of producing power from the potential energy of falling water and invariably contemplates a definite amount of water; the limitation being because of steam or seasonal probabilities—investment involved and market for power. With therefore a given water quantity which however may be, and usually is, variable during seasons or hours of the day or both, we must produce the greatest power output. The efficiency of our waterwheels, generators, transformers and line are the practical limits within which we may expect to convert nature's stored energy in the water into salable electric energy. The accom-



panying curves show about how this will come out in this turbine installation and it would be slightly better if the speed was more favorable for the turbine.

From the above it will be seen that no effort is made to obtain close regulation at Borel and safe operation is about all that is necessary. Most accurate speed regulation however is easily obtainable by the application of suitable relief valves and governors in a plant of this character if the conditions warrant the expense of the apparatus.

Mr. Henry concluded his discussion by drawing a diagram which roughly indicated the conditions to which turbines and impulse wheels were best adapted.

H. W. Crozier inquired as to the life of the turbine runners at Borel.

Geo. J. Henry stated that he thought a life of five years could safely be assumed in this case, also that the efficiency would not drop more than 1½ per cent after a year's operation.

Ralph Bennett stated that his examination of the Girard turbines of the plant showed that they had been pitted rather than worn and that some had been broken by stones.

The meeting was brought to a close after a number of minor questions had been answered.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

The Journal extends to all its readers the compliments of this beautiful season of Christmas cheer.

The dictionaries do not recognize the commonly accepted pronunciation of conduit when used to signify a container for electric wires and cables. In its original meaning of a water-course the u in the last syllable is silent, as in circuit or biscuit. Engineering usage tacitly sanctions sounding the u in order to distinguish the electrical from the hydraulic meaning.

Municipal ownership of the electric light and power plants is being actively agitated at Berkeley, California, which enjoys the distinction of having a Socialist Mayor. A recent petition argues that such ownership will bring great revenue to the city treasury and furnish electricity so cheaply that "the houses may be built without chimneys and the clothes washed without work while the family is at breakfast." Unfortunately this "sure-thing game" makes no provision to eliminate death and taxes.

Elevator Bill

The latest attempt of San Francisco's discredited political administration to perpetuate its pernicious principles in the government of a long-suffering people is found in the so-called elevator bill. Masquerading as a measure for public safety, it is so fraught with dangerous provisions as to be a veritable wolf in sheep's clothing.

This bill provides that no elevator in this city can be operated by a non-licensed man, said license being obtainable only through the medium of the politician. Incidentally, it thus elminates the automatic elevator, the culmination of long years of experimentation. It further forbids an operator to even replace a blown-out fuse, such a delicate operation requiring the services of an "inspector," one of a small army of unnecessary tax-eaters. The inconvenience and lost time involved in the ensuing delay is to be compensated by the added sense of security that the elevator-user must feel in knowing that he is being so thoughtfully cared for by a parental government. Imagine the possibility of business damage if the experienced electrician in a large office building cannot make minor repairs until an inspector appears on the scene.

As the passage of this bill would tend to seriously limit the installation of electric elevators, its defeat is of vital interest to all electrical men. With this purpose in view, the newly formed Electrical Development League is bending every effort to prevent the enactment of this vicious proposal.

Origin of Oil

The readers of this journal are large users of oil, whether for fuel or for lubrication and, as such, would have been interested in a discussion on the origin of petroleum which took place at a recent meeting of the California Section of the American Chemical Society. This discussion was based upon a paper by Paul W. Prutzman, a recognized authority on California oils. While the solution of this question must depend upon the chemist and geologist, the answer possesses the same interest to

the engineer as does the history of any other important branch of his work. For petroleum is but the concentrated result of nature's work through long ages of the earth's history.

The theories as to the genesis of petroleum are as numerous as the places where it is found and as plausible as the stories of those who sell oil stock, and frequently as freakish. The legitimate hypotheses may be grouped, in the words of the old physical geography, under "the animal, vegetable and mineral kingdoms." More technically the origin was either organic or inorganic. The preponderance of evidence, as adduced by Mr. Prutzman, favors the former, especially the vegetable theory.

The mineral theory, which ascribes the formation of petroleum to the reactions between water and the earth's various carbides with the evolution of acetylene, does not account for the fact that there is no known artificial process of producing paraffine or asphaltums from acetylene. As these bodies are essential constituents of all petroleums this explanation must be considered incomplete and therefore doubtful.

The theory of animal origin does not provide for a sufficient supply of raw material, nor does it account for the nitrogen compounds in the oil, though it is otherwise quite tenable. The fatty residues of marine organisms might well have been subjected to destructive distillation and thus produced oil. But only the most credulous will fail to see the joke in the claims that petroleum had its beginning in the "juice squeezed from buried whales."

Mr. Prutzman's observation and reasoning favors the dry distillation of long accumulated vegetable matter as the most legitimate source. Much organic material has found its way to the ocean and there been deposited in shales. At times of land subsidence these shales were frequently lowered into a zone whose temperature was 600 degrees or more, a temperature sufficient to distill petroleum. This theory is confirmed by the artificial heating of many California lignites and shales and subsequent removal of all soluble matter by washing with water.

The further problems as to how the oil flowed to the sands and its accumulation there are those of simple mechanics and complete the cycle of a simple and credible explanation. Though such speculation seems idle, it is none the less interesting to trace Nature's methods of making and storing the oil which is now of so much industrial utility.

Franchise Granting

Too much emphasis has been placed upon the public service franchise as a source for private profit and too little attention has been called to the corresponding burdens and responsibilities to which it subjects those who serve the common needs of the commonwealth. This mistake originated with the corporation, which used the franchise as a means of exploiting the public necessity for light, heat and rapid intercommunication. This rash policy was a boomerang and has been responsible for much of the deserved disrepute into which many companies have fallen. It has lent a fictitious value to these privileges and has justified some of the present unreasonable demands of franchise granting authorities.

Many illustrative cases can be cited in proof of this, but the nearest and latest is that of Multnomah County, Oregon. There the county officials, in retaliation for the refusal of the electric power and telephone companies to grant special rates or free service to the county, now question their right to occupy the county roads with their pole lines. That these corporations pay a large part of the taxes which maintain the county government and that this government is no more entitled to free service than any private citizen are entirely overlooked in this attempted hold-up.

The franchise is a public function frequently delegated to private parties because the public is unequal to its performance. Its execution requires large capital, great executive ability and certain technical knowledge, a combination of qualifications seldom found in a county government. These projects often involve considerable risk as to ultimate profits and statistics show that less than four per cent is annually paid in dividends on the stock and bonds of the electric light and power companies of this country. In comparison the grocery and meat business, a semi-public service requiring no franchise, is a bonanza. The obligations to give adequate service are necessarily binding and the liability for accident most severe. Because of these drawbacks many a promoter finds capital deaf to his pleadings as the inducements are not sufficient.

Thus it is seen that a franchise, of itself, has but little initial value and that the ultimate return is entirely dependent upon the energy and ability of its owners. To make an exorbitant charge for a franchise is but to tempt the promoter to correspondingly overcapitalize his project and consequently defeat the real purpose for which the franchise is granted, good service at low cost.

The first essential in granting franchises is not to enrich the county coffers, nor even to insure lower rates for the consumer, but primarily to maintain control over the rights of way so that the ordinary uses of the roads and streets will not be hindered. Harking back to the etymological derivation a franchise should "make free." No county or municipality has the experience possessed by an unbiased group of men, such as a public service commission, in handling these problems. Every dictate of reason suggests that local authorities delegate their power of public utility control to a centralized commission whose rulings will be at once uniform and just. Here possibly will be found the eventual solution of the franchise problem.

The California Legislature has passed the public utilities bill giving the State Railroad Commission power to fix rates, regulate standards of equipment and service, and annul unapproved bond issues.

PERSONALS.

H. C. Dowler, who is connected with the Gilroy Gas Company, is at San Francisco.

Fred L. Webster, Pacific Coast manager for the Allis-Chalmers Company, is at Seattle.

H. A. Keyes, president of the Sacramento Natural Gas Company, was a recent San Francisco visitor.

R. L. Yates, hydraulic engineer of the Platt Iron Works Company, was at San Francisco during the past week.

C. F. Conn, of the engineering staff, of J. G. White & Company's Pacific Coast branch office is visiting the firm's New York office.

J. J. Mullen, vice-president and general manager of the Moloney Electric Company of St. Louis, visited San Francisco during the past week.

Arnold Pfau, hydraulic engineer with the Allis-Chalmers Company, of Milwaukee, has gone to Portland, Ore., after visiting Southern California.

C. W. Stone has been appointed manager of the lighting department of the General Electric Company, to succeed C. D. Haskins, deceased.

W. D. Ward, of the Pelton Water Wheel Company's sales department, has returned to San Francisco after a profitable trip through Utah and Idaho.

Dr. Thomas Addison, Pacific Coast manager of the General Electric Company, has returned to San Francisco, after visiting the Los Angeles office of the company.

Fred Poss, San Francisco manager for the Benjamin Electric and Holophane companies, was married to Miss Helen Hansen, of Butte, Montana, on December 13.

S. B. Charters, Jr., of Stanford University, and A. A. Miller, of Seattle, Wash., have been appointed on the membership committee of the American Institute of Electrical Engineers.

Stanley Walton, manager of the Pacific Gas & Electric Company's commercial department, returned during the past week from Chicago, after attending the National Irrigation Congress.

Oliver Dyer Coldin, a former manager of the Seattle-Tacoma Power Company, and who is now manager and vice-president of the Seattle Car Manufacturing Company, was a recent San Francisco visitor.

Frank H. Ray, who is one of the directors of the Great Western Power Company, is at San Francisco, keeping in touch with the interesting situation with regard to a possible consolidation of hydroelectric interests.

D. C. Green, formerly manager of the Oregon Power Company, at Albany, Ore., has been made manager for the Byllesby interests at Marshfield, Ore. His place at Albany has been filled by P. H. Moreton, of Sand Point, Idaho.

William W. Gooch, attorney for Theodore N. Vail, president of the American Telephone & Telegraph Company, is at San Francisco on business said to be connected with the formation of a company by Henry T. Scott and local capitalists for the handling of bottled Blau-gas.

Walter C. Howe, assistant city engineer and ex-officio superintendent of streets of the city of Oakland, has been appointed by the Governor of California as State engineer for the State Highway Commission. He is a graduate of the University of California. The Commission will have the handling of the $18,000,000 bond issue for highway construction.

O. C. Pratt, president of the Indian Valley Light & Power Company, of Greenville, Cal., states that a shipment of ten miles of copper transmission wire has been received. This will be strung on the poles already erected for the extension to Crescent and Taylorsville. As soon as spring opens the system will be extended farther down the valley.

Louis A. Bauer, director of the department of terrestrial magnetism of the Carnegie Institute of Washington, was a recent arrival at San Francisco. He has been visiting the especially built vessel from which a scientific corps are securing magnetic data in the Pacific Ocean.

George J. Henry, Jr., who has been connected with the Pelton Water Wheel Company for the past seventeen years, has resigned his position as chief engineer in order to go into business for himself. He has opened an office as consulting engineer at 757 Rialto Building, San Francisco.

The district managers of the Pacific Gas & Electric Company held their last meeting for the year at San Francisco, December 19. More than twenty districts were represented. The list of managers is as follows: F. A. Leach Jr., F. J. Southerland, H. B. Heyford, L. H. Hartsock, Don C. Ray, W. M. Henderson, John Werry, J. E. Poingdestre, W. H. Foster, O. E. Clark, H. M. Cooper, E. W. Florence, C. W. McKillip, J. D. Kuster, M. G. Hall, C. E. Sedgwick, W. A. Widenmann, A. J. Stevens and W. E Osborn

THE ELECTRICAL DEVELOPMENT LEAGUE.

At the special meeting of the directors and executive committee of the Electrical Development League, held at the secretary's office, 106 Rialto Building, San Francisco, on December 18th, President Geo. C. Holberton announced the following appointments on committees to serve for six months beginning December 12, 1911. Membership Committee, W. L. Goodwin, R. L. Van der Naillen, W S. Hanbridge; Entertainment Committee, W. W. Briggs, R. D. Holabird, A. E. Drendell; Ways and Means Committee, S. J. Lisberger, A. B. Saurman, Russell Waldron; Finance Committee, Chas. Wiggin, H. A Russell, W. F. Neiman; Good-Fellowship Committee, C. H Pennoyer, W. S. Berry, John R. Cole; Grievance Committee, Vanderlyn Stow, T. E. Bibbins, F. B. Gleason; Publicity Committee, C. L. Cory, J. W. Redpath, A. H. Halloran. The nominating committee was purposely not appointed as it would have been no work for the coming six months.

As a result of a drawing J. A. Vandegrift and P. Decker take the one-year term and C. C. Hillis and W. W. Hanscom the six month's term on the executive committee.

President Geo. C. Holberton and W. W. Hanscom were appointed to represent the Electrical Development League in protesting against the passage of the proposed elevator bill in San Francisco.

ELECTRICAL CONTRACTORS' NOTES.

The Pacific Fire Extinguisher Company has started to install the conduits in Sacramento's new court house.

Much has been said about the good that could be obtained by contractors if they were all asked to figure on the same specifications.

The Standard Electrical Construction Company has been awarded the electric work for the Southern Club, on Powell and Joice streets. C. A. Nuesdorfer is the architect.

Bids for electric work on a new hotel on Sutter street, between Kearny and Montgomery, were received by the Regents of the University of California, but the job has not been awarded yet. Estimates on electric work run about $20,000.

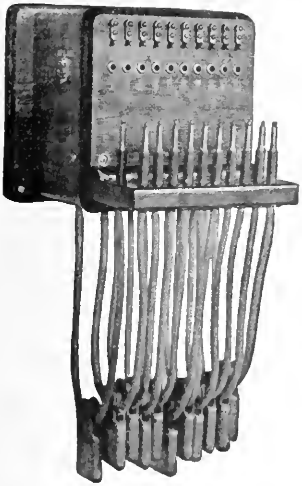
The Butte Engineering & Electric Company has been awarded the electric work for the Mt. Zion Hospital for the sum of $7592. This building, when completed, will be one of the most up-to-date, Architect Kraft having spent a number of months in the East going over some of the principal hospitals in the country.

Secretary Hanbridge is distributing among the architects throughout the State a copy of standard specifications as adopted by the National Electrical Contractors' Associations. If same were adopted generally, a big step in the right direction would be started. Copies can be had by sending a postal to 329 Lick Building, San Francisco.

INDUSTRIAL

NEW KELLOGG SWITCH BOX.

For the convenience of those customers who prefer a ten line switch box equipped with shelf for plugs, the Kellogg Switchboard & Supply Company have arranged the box as shown in the illustration. This arrangement of cords takes less room below the cabinet on the wall and is preferred by some because of the added compactness.



Kellogg 10-line Switch Box.

Some of the advantages claimed for this new ten line switch box are:

Extreme simplicity.

No expert attention required in maintenance.

Economical. Present central office telephone equipment can be retained in service if desired.

No drops to be "restored" when patrons are merely ringing other parties on their own line.

All lines terminate at office on extension bells of same resistance as bells on the line. This insures balanced conditions and makes it possible for central to be rung efficiently as any party on the line.

MULTI-DIFFERENTIAL ARCH TYPE OF CELLULAR DAM.

The curved principle in dam building is now rapidly gaining recognition, and it will surprise the general reader to know that this principle was recommended as a "precaution only," a "moral satisfaction," and "pleasing effect," by scientists and eminent engineers only a few years ago, and a stupid waste of material and labor, or a joke, by engineers generally.

The fundamentals of a perfect dam structure may be summarized as follows:

1. The materials should be indestructible through exposure to the elements.

2. The pressures on the base should be vertical and uniform, or nearly so, and without effort to slide with water pressing on one side.

3. The form of the dam should be such that there is no effort to overturn no matter how the forces acting on the structure may be varied.

4. The form of the dam should be such that the materials sustain compression only in every part of the structure no matter how the forces acting may be varied.

5. The resistive efficiency of the dam as a whole should be constant no matter how the forces acting may be varied.

6. The form of the dam should admit of perfect drainage and uplift pressure impossible in any part of the structure, or beneath it.

7. The form of the dam should admit the passage of ice and drift in a jam and the expansion of ice, due to changes of temperature, by changing the angle of thrust on the structure from a horizontal.

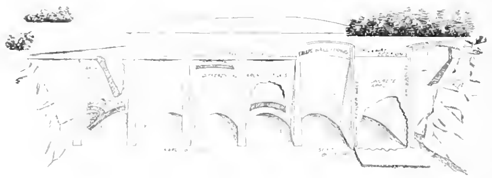
8. The form of the dam should be such that stress due to changes of temperature is accommodated within the elastic limit of the material.

9. The dam as a whole should be an ultimate type of structure, or stable under any condition other than a rupture of the earth's surface at foundation.

10. The cost of the dam should vary directly as the pressure of the water, above foundations.

The multi-differential arch type of cellular dam, shown in the accompanying cut answers all the principles of a perfect structure. A simple inspection of this cut shows that all the material must be in compression. Principle 4.

Extending this reasoning the following step evolves the fact that the crushing strength of the material is the ultimate strength of the structure; and, taking 13.5 tons per sq. ft.



Multi Differential Type of Cellular Dam.

as a maximum unit pressure, (can be made any strength desired, of course) the safety factor for Portland cement concrete is 16, which has been adopted as a standard for this structure.

The form of the structure embodies the principles of the old wooden dam, and the pressure on the base is vertical, or nearly so, and such structure cannot slide with water on one side; and it does not require a superior knowledge of hydromechanics to understand that the lines of pressure in this structure are not changed by increasing the pressure of the water. Any increase of depth of water on the crest of the dam increases the pressure on the structure proportionately without changing the lines of stress. Hence the greater the pressure on such structure the greater security against sliding. Principles 2 and 5.

While water acts the same in the standard gravity type an increase in the pressure of the water is not followed by an increase in the weight of the masonry and the lines of stress change progressively in a diminishing advantage of the vertical force and in the direction of the horizontal force. Following this last step in our reasoning it will be readily understood that a structure with pressure nearly vertical on base cannot overturn, and as such pressure is increased the security against overturning must be increased. Principles 3 and 5.

Simple masonry, cement, sand and stone, is absolutely indestructible, which is beyond controversy. Principle 1.

It is well known that masonry is elastic, will bend with-

out fracture, and that such deflection is sufficient to accommodate arch action, since arched wall seldom crack while straight ones nearly always crack through changes of temperature and varying conditions of moisture. Prof. White shows that the difference due to such changes of temperature, in about 50 ft. length of wall, is about ⅜ inch, which is entire within the elastic limit. The stress due to simultaneous differences of temperature throughout a wall is peculiar to very thick walls only. Such stress cannot occur in the thin walls of cellular dams. Principle 8.

By a further extension of our ideas to embrace seepage and the percolation of water under pressure within and beneath a structure, we can understand that internal pressure must be resisted by weight and cohesion of cement in a gravity structure, the essential constructive elements of reaction in this type, and any individual part of such structure can be dislodged, and removed, by a force equal to the weight and cohesion of such part, which force is comparatively inconsiderable; and a sufficient area of internal water pressure can readily accumulate in such structure and overcome the weight of cohesion of a large part of the structure; which is frequently the case, causing cracks on the face not extending through to the back of structure. Also uplift pressure through the penetration of water between structure and foundation, which is practically unavoidable in gravity dams.

The essential constructive element of reaction in an arched structure is compression of the material, and weight and cohesion non-essential, and no individual part of such structure can be dislodged by a force less than the crushing strength of the material, which is the ultimate strength of the structure. Hence the percolation of water under pressure within and through such structure is harmless. It is also clear that any accumulated internal pressure must always be an inconsiderable part of a force necessary to destroy such structure. Further, the essential formative principle of construction in all cellular types precludes the possibility of uplift pressure, through perfect drainage. Because there is not sufficient area at any one point of base, to afford significant pressure by the penetration of water beneath structure, or between base and foundation. A simple inspection of the cut will make this clear. Principle 6.

The form of all cellular masonry dams with sloping water face affords the necessary resistive properties in the passage of ice and drift in a jam or the expansion of a pond ice sheet through changes of temperature. Any horizontal pressure on a sloping plane is afforded relief by pushing up, rising, on the slope, and the force exerted cannot exceed the actual weight of the body creating the pressure. Usually, in the dams referred to, this is about one-half the weight of such bodies. Then, taking an ice jam 10 ft. thick, passing crest of dam, the horizontal thrust would be about 300 lbs. per lineal ft. of dam. Ten times this amount would be an insignificant thrust on such structure. Principle 7.

Concluding this reasoning, as to stability, it is clear that an ultimate type of structure must answer fully all the fundamentals enumerated, from 1 to 8 inclusive. A seismic rupture of the foundation of such structure would not necessarily destroy it. Principle 9.

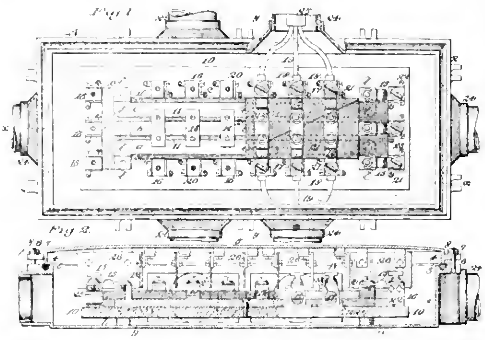
Finally, the volume of material in cellular masonry dams increases directly as the unit pressure of water. Hence the cost of such structures is directly as the height and the power developed, or energy conserved. Principle 10.

E. H. Libby, of Clarkston, Wash., has been spending a few days in San Francisco, while looking over the State of California for data on electric pumping for irrigation, etc. He states that northern railroad officials admit that while last year the percentage of growth of immigration in the State of Washington was double that of California, this year the trend of the colonist travel is strongly towards the Golden State.

A NEW UNDERGROUND ELECTRICAL JUNCTION BOX.

A simple three-phase, low voltage, six-way junction box for underground conduit systems has recently been patented by S. J. Lisberger and C. J. Wilson of the Pacific Gas & Electric Company. It not only occupies a minimum of space but is also moisture-proof, easily repaired and quickly renewable.

Figs. 1 and 2 give the plan and vertical section of the box with cover removed, this cover fitting into a flange and rubber gasket and being tightly held by bolts and nuts so as to exclude all moisture. The three insulated bus bars a, b, c, are mounted on a non-conducting slab and support a series of posts, 12, with overhanging brackets. These brackets are staggered and serve as contact blocks for fuse



A New Underground Electrical Junction Box.

terminals attached to them and giving connection through fuses to a series of terminal blocks opposite each bracket. Adjacent bus bars, brackets and terminal blocks are carefully insulated and danger of short circuit in case of fuse blow-out prevented a series of insulating barriers mounted on the underside of the cover, so as to extend between the fuses and brackets.

By the peculiar construction of the outermost bus bars they may be formed from one pattern and are inter-changeable. It will also be observed that these bus bars a, b, c, are each formed in one piece, the bus bars, posts and brackets being integral, thus avoiding the use of joints, either soldered or otherwise connected. The invention is thus seen to comprise a simple and compact means of mounting the conductor terminals in the junction box and means for insulating the various conducting parts from each other.

TRADE NOTES.

Ralph L. Phelps, Pacific Coast manager of the Safety Insulated Wire & Cable Company, is distributing an excellent eraser which bears a remarkable resemblance in appearance and composition to the "Ruby Core," which distinguishes Safety rubber-covered wire.

The Washington County Telephone Company, of Hillsboro, Oregon, which recently took over the local system of the Pacific Telephone Company, has purchased additional equipment from the Kellogg Switchboard & Supply Company. O. G. Wilkes is president of the company and George Schulmerich, secretary-treasurer.

The Sprague Electric Company announces that since October 1st, 1911, they have manufactured only such "BX" Cable and other flexible steel armored conductors as will comply with the new code requirements effective on January 1st, 1912, and these products which have been manufactured since October 1st, 1911, also comply with the requirements of the City of New York and the City of Chicago.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. PROGRESS 1911

The year 1911, like its immediate predecessors, does not represent any very remarkable inventions or startling improvements in the field of electricity, but rather a general tendency to standardize the improvements already made and some further perfections of existing models.

The design of apparatus, in many cases, only covers a small part of the general engineering points which have to be considered in a proposition. There is such a broad view of general conditions, which it is always well to review and these conditions tend largely to direct engineering matters. At present, the general slogan of the country is "Economy." Central stations are improving their load factors, are devising better arrangement of apparatus, purchase more efficient apparatus, such as turbines, and to obtain more patronage are revising their rates, offering their customers a decided saving as compared with the individual power proposition.

The development of the line alternating current turbo generators has not been particularly spectacular in the past year. No machines larger than the previous ones have been sold, but certain negotiations are under way, looking to some very large capacities.

During the past year the Westinghouse company has placed on the market an entirely new line of direct current engine-driven generators. These generators possess many unique and desirable features. The line is of the commutating construction and ranges in size from 25 kw. to 1000 kw. The smaller generators are standard for 125 and 250 volts only, while the larger ones are for 250 and 600 volts. The frames of these generators are of cast steel and the ventilattion has been very carefully worked out with exceedingly satisfactory results. In actual operation, they operate at low temperatures and, due to the interpole, practically perfect commutation is obtained. This is the first complete line of interpole engine type generators of all voltages to be placed on the market.

Considerable progress has been made in the design of rotary converters during the year, especially in connection with the design and tests on rotary converters for high voltage service. While very few single rotary converters for 1200 or 1500 volts have been placed in operation by any manufacturer, there is every reason to believe that the ensuing year will see a number of properties where individual 25-cycle rotary converters of 1200 and 1500 volts direct-current are used for transforming alternating to direct current. Such rotaries will undoubtedly be of interpole design.

The continued growth of long distance transmission lines with the increased use of electric energy taken from them particularly in relatively small amounts has greatly stimulated the demand for outdoor apparatus and to this end the Westinghouse Company has been of great service in placing on the market after thorough trial in actual service on the lines of the Southern Power Company, the outdoor type GA oil circuit-breaker for voltages from 40,000 to 11,000.

Economy being the watchword of the times, it has found expression in switchboard work and the Westinghouse company has greatly aided in this direction by bringing out the seven and nine-inch dial indicating meters for switchboard work, thus greatly economizing space on the board.

No sacrifice has been made in accuracy, efficiency or appearance by this new design, and it enables considerably more apparatus to be mounted on a given panel or a smaller panel is required for a given lay-out.

Further developments have been made in the manufacture of induction meters by the damping feature and securing increased torque without increased weight.

Additional development has been made in direct current motors by use of the simple air gap D'Arsonval principle.

To meet the popular demand from central stations for a less expensive watthour meter, the Westinghouse Company has placed on the market this year the type OA watthour meter which fully meets this demand. This is a less highly finished meter than the well known type C and has some of its points of refinement omitted, but is entirely satisfactory for small or medium sized loads and is meeting with great success.

WESTERN ELECTRIC COMPANY.

During the past year, the Western Electric Company has contributed to the world at large, its full quota of new developments in the fields which have made it universally famous, and, in effecting innumerable improvements in existing types of apparatus, has more than kept abreast of the march of progress. In telephone apparatus the most noteworthy achievements are in railway train dispatching, where the Western Electric loud speaking receiver has been perfected. The "Group" selector, has also been introduced and placed with a great deal of success on the lines of a number of railroads. It is designed so that the dispatcher by operating his selector key first picks out automatically a group of five selectors and then a particular selector of the group. A selectively operated semaphore is another new development.

The Westeru Electric has developd an application of its well-known "Inter-phones" to the needs of apartment houses. For the suites, Inter-phones of the flush or non-flush, metal or wooden types are used. The line is complete, including sets for the vestibules and for the use of janitors and tradesmen. A new wooden type "Inter-phone" telephone set has been placed upon the market. Another development which will be of value in Inter-phone installations is the new type of cable terminal (No. 19) which has recently been placed on the market, and is so designed that all connections may be made by means of a screw driver. A vacuum lightning arrester, designed primarily for railroad telephone equipments, has been introduced and is meeting with much favor wherever used, on account of its very low maintenance cost and high efficiency. A new central battery series telephone set, with specially designed transmitter and receiver, fills a long felt want for an inexpensive set to be used on short lines where, for all practical purposes it will give as good service as a set with an induction coil. The set may be used interchangeably with regular common battery sets on all common battery lines.

Unit type distributing frames for common battery multiple switchboard installations have been developed. These may be added to as the need for additional equipment becomes apparent and they are so designed that a considerable saving is effected in cabling.

Other developments of equal importance are switchboard lamps having the end of the glass bulb made into a lens to intensify the light; a new and improved tinsel cord developed after considerable research work, having a longer life and making for better transmission than any heretofore developed; and new switchboard keys to be used in connection with harmonic ringing systems. The latter are very compact in construction and have a locking feature showing which ringing button was used last.

The Pelton Water Wheel Company has been awarded the contract for the complete hydraulic equipment of the hydro-electric power plant at the Gatun locks of the Panama Canal. This comprises three 3600 h.p. vertical shaft Pelton-Francis water wheels to operate at 250 r.p.m. under 75 ft. head. The wheels will be direct connected to General Electric generators and regulation will be accomplished by means of Pelton oil pressure governors. The contract also calls for 300 ft. of pipe line for each unit, the pipe being 10 ft. 6 in. in diameter.

NEWS NOTES

INCORPORATIONS.

SAN FRANCISCO, CAL.—California-Oregon Power Company, San Francisco, $10,000,000, shares $100 each, subscribed $500, by A. L. Whittle of Mill Valley, E. Schwab of Hohfeld, J. F. Shuman and F. H. Lorigan.

SAN FRANCISCO, CAL.—The Thermo Electric Company, San Francisco, $50,000, shares $10 each; subscribed $50, by F. C. Morgan, T. S. Crellin, M. H. Shoeberg, G. T Marsh and E. M. Mason, 1 share each.

SAN FRANCISCO, CAL.—Northern Power & Water Company, San Francisco, $25,000,000, shares $100 each, subscribed $900, by C. W. Willard, F. E. Boland, H. L. Atkinson, J. B. McKeon, T. A. Allan, S. I. Langmaid, J. F. Cassell, P. J. Muller, A. C. Greene.

SACRAMENTO, CAL.—Articles of incorporation have been filed by the Yolo Water & Power Company, a $10,000,000 concern formed by Oakland men. The incorporators are Leon M. Gove, H. L. Breed, Chas. Gross, J. E. Bowes, and H. S. Hamilton, all of whom have invested $500 of the $2500 of paid up capital.

BOISE, IDAHO.—The Southern Idaho Light, Heat & Power Company has been incorporated with a capitalization of $20,000,000. William Mainland is president, and O. G. Markhus, resident agent. It is thought that the new corporation will become a holding company for all power and electric companies in this part of the State.

TRANSMISSION.

THE DALLES, ORE.—The Pacific Power & Light Company has been granted a franchise to maintain an electric light and power system here.

HOXEE CITY, WASH.—Officers of the Hoxee City Commercial Club have signed a contract with the Pacific Power & Light Company, for power and lights.

WASHOUGAL, WASH.—The Northwestern Electric Company has been granted the right to operate an electric light and power system in Washougal, Clarke County.

VANCOUVER, WASH.—Surveyors are locating the right-of-way for the new electric line to run from Washougal and White Salmon. The line is to be in operation within two years.

VERNON, B. C.—Rights have been secured by the C. P. R. to develop hydroelectric power on the Adams River. It is expected that 100,000 horsepower will be eventually developed.

DAYTON, WASH.—The Pacific Power & Light Company has applied to the county commissioners of Columbia county for permission to operate power and light lines through the county.

LOS ANGELES, CAL.—City Electrician Monahan has recommended that poles and wires be placed underground on over 3½ miles of street, in addition to the present conduit district.

VICTORIA, B. C.—The Wellington Colliery Company has secured a government permit for the construction of a power and impounding dam on the Punt Ledge River, near the outlet of Comox lake.

BAKER, ORE.—The Central Oregon Power & Irrigation Company, which is planning to irrigate 40,000 acres in Harney County by pumping water from Malheur Lake, has elected the following officers: President, W. A. Pope; Vice-President, S. S. Start; Secretary-Auditor, C. T. Godwin; Treasurer, Mrs. Blanche Rhinehart; Directors, W. A. Pope, W. C. Parish and S. S. Start, all from Baker, except Parish, who is engineer for the Pacific Electric & Power Company, of Walla Walla.

MARTINEZ, CAL.—The Great Western Power Company which has entered the Contra Costa field in competition with the Pacific Gas & Electric Company, will extend its lines across the Straits at Carquinez in the near future.

MYRTLE POINT, ORE.—It is understood that a syndicate is in process of organization for the purpose of developing power on the south fork of the Coquille. The generator is to be located about 30 miles from this place.

CAMAS, WASH.—A franchise has been granted to the Northwestern Electric Company to furnish light and power to the town. The power will also be furnished to the paper mill. A big dam on the White Salmon River will develop 10,000 horsepower for the new company.

CHEHALIS, WASH.—Acting upon the request of the Washington-Oregon Corporation for a fifty-year franchise to furnish light and power to the town of Adna, the county commissioners have made the following proposition to the company: A ten-year franchise will be granted to furnish light and power to Adna, providing the corporation will furnish and maintain four sixty-watt tungsten lights for the county, two to be placed on the bridge at Adna over the Chehalis River, one at each end and two between the bridge and the railway station.

PORTLAND, ORE.—A temporary injunction has been granted in the United States Circuit Court by Judge Bean against the Hydroelectric Company, of Hood River, to restrain it from interfering with the electric wires of the Pacific Power & Light Company, near that city. The Hydroelectric Company was organized at Hood River to furnish that city and The Dalles with electric lights and power. To accomplish this the company built a dam across the river four and one-half miles south of Hood River, with which it generates its power. Leading thence and along the county road it has erected poles and stretched wires parallel to and at times crossing these of the Pacific Light & Power Company to the detriment of the latter's business, it is charged, by causing short circuits.

ILLUMINATION.

ROSEVILLE, CAL.—Sealed bids will be received by the Board of City Trustees up to 7:30 p. m., January 8th, 1912, for the furnishing and supplying of such electric energy as may be required by the city of Roseville for the period of 5 years. Said electric energy to be three-phase sixty cycle, and approximately 2300 volts pressure.

PORTERVILLE, CAL.—Attorneys representing the Tulare County Power Company, the newly organized co-operative concern which is being financed by the ranchers of this district, have applied to the City Council for a 50-year franchise which will give to the company use of the city streets and alleys for all necessary construction for the distribution of electrical energy.

RENO, NEVADA.—The work of building the new power plant on the Truckee River, seven miles east of Reno, is soon to commence. The ditches to supply this plant have already been surveyed and partly completed. This plant is to be owned by the Nevada Valley Power Company, which now has a monopoly on the power and electric lighting business of this portion of the State.

SACRAMENTO, CAL.—Approximately $2500 was saved to the State by the State Board of Control in awarding

three contracts for electric light globes for the State institutions. The contracts combined call for the purchase of approximately $10,000 worth of bulbs during the coming year. The General Electric Company, the Pacific States Electric Company, and the Pacific Gas & Electric Company were the successful bidders.

PALO ALTO, CAL.—Charging that the Pacific Gas & Electric Company is operating without a franchise, the Board of Public Works has adopted a resolution calling the company to account, and recommending that the City Council take ouster proceedings. It is alleged that the lighting company received a permit to do business in the city in 1896 for a term of 23 months, and that permission has never been extended in its case.

TRANSPORTATION.

CALDWELL, IDAHO.—Construction on the Caldwell-Nampa Electric Railway has been begun. It is expected that cars will be running in 60 days.

BOISE, IDAHO.—The Boise railroad will ask for a right-of-way through the streets of South Boise for the purpose of opening up an interurban line between Boise and Beaver Dam.

LOS ANGELES, CAL.—The Pacific Electric Company has been granted the right to electrize the old Santa Monica air line, thus providing new car service to the western beaches and crosstown to the rapidly growing districts.

BELLINGHAM, WASH.—The franchise of the Nooksack Valley Traction Company has been extended, permitting the company to defer the beginning of actual construction until October 1, 1912. The road must be completed not later than October 12, 1914.

RIALTO, CAL.—The Crestmore officials who own the trolley line operating between Riverside, Crestmore and Bloomington, have purchased ten acres at the Bloomington end of the line, thus clearing the way for the building of a trolley line into Rialto from Bloomington. Work on the line will be rushed.

MARYSVILLE, CAL.—With the filing of a deed of trust from the Marysville-Colusa Railroad Company to the Mercantile Trust Company of San Francisco to secure a bonded indebtedness of $1,000,000 comes the report that the construction of the electric railroad between the two cities will be commenced at once.

BERKELEY, CAL.—The next step to be taken by the Southern Pacific Company will be the changing of the West Berkeley line into a through electric system to connect directly with the boats for San Francisco at the Oakland Pier. This line will cost in the neighborhood of $500,000 and will mean the building of three new power stations.

PORTLAND, ORE.—Complying with the recent order of the State Railroad Commission, the Portland Railway, Light & Power Company has announced its intention to establish a 5-cent fare between Portland and Hendee, Ardgour, Lambert and Knights, on the Oregon City division of the Oregon Water Power line, beginning Friday. These were the stations to which the company wanted to maintain a 10-cent rate after the Commission had ordered a reduction. The matter will be finally settled, in all probability, in accordance with the findings in the Milwaukee case now pending before the U. S. Supreme Court.

LOS ANGELES, CAL.—Rerouting the street car lines of Los Angeles to relieve the congestion that has made transportation in the rush hours dilatory, was begun Sunday, when three changes were established. In a few weeks, or as soon as the company can obtain the tracks for the purpose, six other lines will be changed, according to the plans outlined last week by the Board of Public Utilities and which that board approved in full. The plans have been in the process of making for eleven months. The three lines changed are: Washington street and Maple avenue lines, which will be joined and pass from their present routes across Fifth street, between Maple avenue and Olive streets. West Ninth street and Brooklyn avenue lines which will be operated by way of Spring street, North Main street and Macy streets. West Eleventh street line, which will be operated on Broadway street to Second street and across that street to the Santa Fe station. By these changes, and the six others approved, the street car company will be permitted to reduce the number of cars on curves from 2586 daily to 1900 and also to eliminate thirty curves in the congested region. When all these changes are brought about it is believed the transportation problem will be as far advanced toward quick facilities as it can be without the diversion of the interurban traffic to San Pedro street, which is possible within a year.

TELEPHONE AND TELEGRAPH.

SITHERLIN, ORE.—M. A. Ralston and E. Wickizor have been granted a telephone franchise in this city.

NEVADA CITY, CAL.—The Tahoe national forest is to have a private telephone line between Nevada City and North Bloomfield.

LOS ANGELES, CAL.—It is reported that an agreement or possible merger will soon be effected here between the Home Telephone Company and the Postal Telegraph Company.

SAN FRANCISCO, CAL.—The permit to allow a merger of the Home and Pacific States Telephone Companies is on the shoal of municipal ownership, and has been dropped indefinitely by the Board of Supervisors.

RICHMOND, CAL.—A representative of the Pacific States Tel. & Tel. Company was in this city and with Manager Calvert of the local system talked over the advisability of extending the main distributing line. It is planned to put in a distributing line for the accommodation of about 4000 telephones within the coming year.

SANTA ANA, CAL.—Legal demand has been made on the Pacific Telephone & Telegraph Company that it take out a franchise if it wished to continue doing business here. The demand was made on the local agent here, and will be referred to the main offices. This action by the City Attorney follows a court decision rendered in favor of Pasadena whereby the telephone company was compelled to take out a franchise in that city.

LOS ANGELES, CAL.—The expected suit of the Home Telephone & Telegraph Company against the city of Los Angeles, to prevent the enforcement of the rates provided for by the resolution of the Council adopted July 28, 1911, was filed in the United States Circuit Court last week. It is claimed that the schedule of rates is much lower than the rates prescribed by the resolution of the Board of Utilities. It is further set out that, prior to the adoption of the resolution by the Board of Utilities, there was submitted a statement setting forth an estimate of the value of the physical properties of the Home Company (exclusive of working capital), and that the total was $5,764,545.59; that the complainant, finding itself compelled to seek relief through judicial proceedings against the rates prescribed by the ordinance, caused a new inventory and appraisement to be made of the property when the total reached $6,926,457.55. It is further alleged that the total gross earnings for the operation of the system amounted to $1,192,622.89; expenses, $1,153,849.69; total expenses outside of the city, $13,056.82; net returns on the investment amounting to .5597 of 1 per cent, which, in the opinion of the complainants, is too small for the investment.

ALPHABETICAL INDEX TO ADVERTISERS

Form 2589 B

DAY LETTER

THE WESTERN UNION TELEGRAPH COMPANY

INCORPORATED

25,000 OFFICES IN AMERICA. CABLE SERVICE TO ALL THE WORLD

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JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXVII | SAN FRANCISCO, DECEMBER 30, 1911 | NUMBER 27

STORAGE BATTERY FOR GOLDFIELD MINES

The Goldfield Consolidated Mines Company of Goldfield, Nevada, has had some unique problems to deal with in the handling of their power demands, due to isolated location, peculiar conditions of load and a number of other interesting factors to contend with.

Since the formation of the Goldfield Consolidated Mines Company, which took over the holdings and workings of a number of smaller companies at Goldfield, Nevada, it has been the aim of the management to make use of the most improved methods of mining and milling. The new "million dollar," 100 stamp, cyanide mill with electric drive throughout, has a record for economical production that is truly remarkable, considering its location in what is practically a desert country. Scarcity of water, as well as the high cost of fuel, make the use of water power from the distant mountains almost imperative. Power for the new mill and for the mines and various other properties of the company is supplied from a central distributing substation belonging to the company, where the aggregate load, as well as that on each feeder, is measured and controlled. Power is received at this substation at 6600 volts, 3 phase, 60 cycles, and redistributed without transformation, except for a small part which is used for the compressor station at 440 volts. This compressor plant formerly carried the two principal mine hoists, which were driven by air. At that time the average load on the substation was about 1400 kw., with a good load factor, about 80 per cent. Power is obtained from the transmission lines of the Nevada--California Power Company on a straight maximum demand basis, and, consequently, it is desirable on the part of the mining company to maintain a high load factor, and it is imperative also, on account of the characteristics of the system, to maintain a fairly steady load.

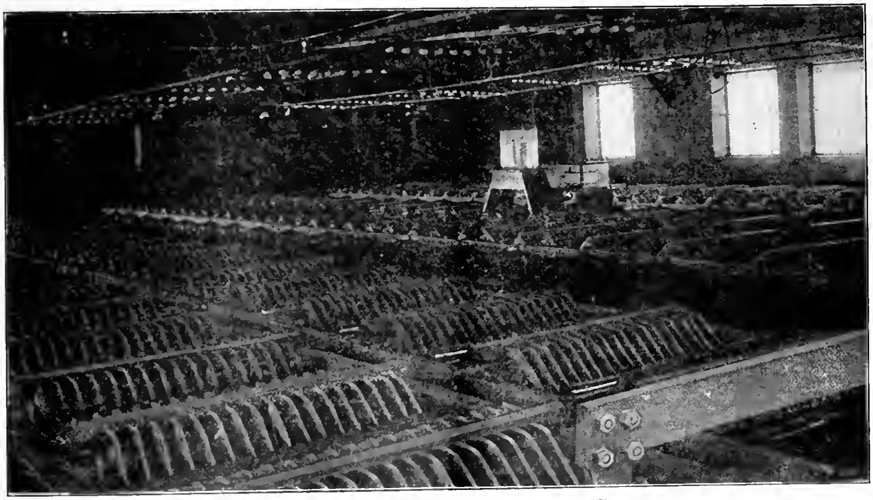

Fig. 1. Battery Room at Goldfield Cons. Mine.

The Nevada-California Power Company operates a duplicate transmission line from a series of hydroelectric stations on Bishop Creek, California, about 100 miles distant from Goldfield. The diagram, Fig. 2,

shows the general arrangement of the transmission system. The total average load is under 8,000 kw. With this comparatively light load on so long a transmission line, and with a potential of 60,000 volts and 60 cycles, the line characteristics are such that comparatively small changes of load will cause considerable variation of voltage at the receiving end, and violent fluctuations of load are liable to set up power surges.

During the summer months there are frequent and violent thunder storms in the mountains crossed by the lines and, although damage is prevented by the lightning arresters, occasional opening of the circuit breakers is unavoidable with consequent troublesome shut-downs of short duration.

As above mentioned, the two principal hoists were originally installed with air drive. The air was supplied by two electrically driven compressors, and, although these machines were efficient in themselves, the energy efficiency of the entire system, in comparison with direct electric drive, was necessarily very low. This wasteful method was thought to be justified at the time by the terms of the power contract and the necessity of preventing sharp fluctuations in the load, such as would be caused by the direct application of large induction motors to the hoists.

Afterward, when the demand for air for drilling had increased until the capacity of the compressors was insufficient for both purposes, the question of the best system of hoisting came up again. Direct electric drive was desired on account of efficiency, reliability, convenience and ease of control; but this was out of the question without some means of taking care of the resulting fluctuations. Two methods were considered—fly wheel sets and a storage battery. The relative advantages of these systems, together with those of the air system already in use, were investigated thoroughly by L. T. Merwin, the electrical engineer of the company, and the storage battery finally decided upon. It was also decided, for practical reasons, to use induction motors on the hoists instead of direct current motors; consequently the entire load is a.c. The purpose of the battery is threefold: (1) to absorb momentary fluctuations; (2) to improve the all day load factor; (3) to furnish current for emergency in case of failure of the power supply.

The scheme is shown in the simplified wiring diagram, Fig. 3. A synchronous motor generator set of 400 k.v.a. rated capacity, wound for 6600 volts, floats directly across the a.c. bus bars, and a storage battery of 120 cells of chloride accumulator, Type G-35, floats across the brushes of the d.c. machine. Regulation is effected by means of a special winding on the field of the d.c. machine, supplied by a special induction motor driven exciter. The field of this exciter is in turn controlled by the carbon regulator, which is equipped with a watt solenoid, connected in the incoming supply line. When the battery is floating, the special exciter is at zero voltage; but it will be seen that any change of power in the incoming line will result in an immediate rush of current in the special field winding of the d.c. machine, causing the battery to charge or discharge, as the case may be, to correct such change. On account of the extremely short time element of the carbon regulator, the correction is made so quickly that the resulting load on the incoming line, as shown on the graphic wattmeter chart, Fig. 5, may be made practically a straight line. The effect of the regulation is seen very clearly by comparing the two charts, Fig. 4 and Fig. 5, taken simultaneously, one on the incoming supply line and the other on the combined outgoing feeders. The main field of the d.c. machine is self excited and is therefore weakened on battery discharge and strengthened on charge, which action assists the special field winding.

Excitation for the synchronous machine is furnished by means of a second exciter, mounted on the motor generator shaft. A Tirrill regulator is connected to the latter for the purpose of regulating the voltage of the incoming supply line by forcing the synchronous machine, within its capacity, to take lagging or leading current as may be required. The lagging components of starting current from the induction motor hoists are fully equal to the energy components and more seriously disturb the voltage. These lagging components are largely absorbed by the syn-

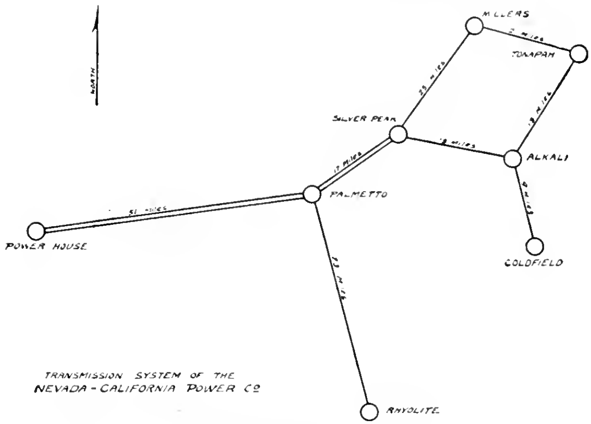

Fig. 2. Transmission System of Nevada-California Power Company.

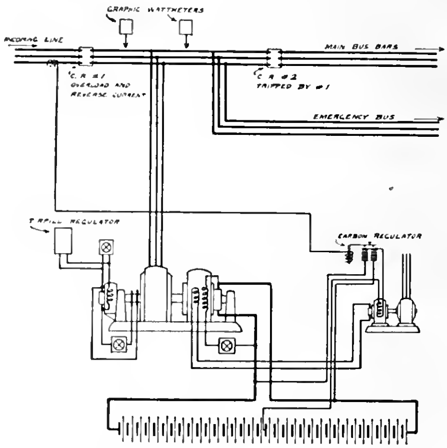

Fig. 3. Simplified Wiring Diagram.

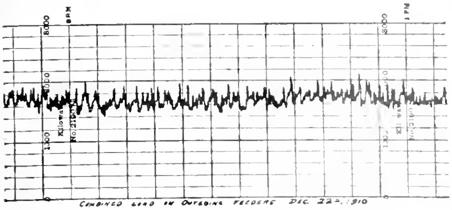

Fig. 4. Meter Record of Incoming Supply.

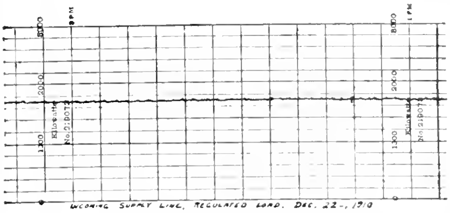

Fig. 5. Meter Record of Outgoing Feeders.

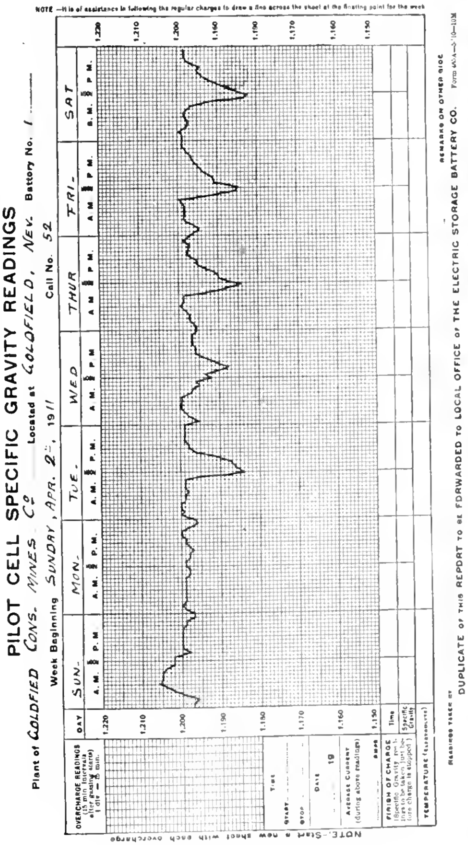

Fig. 9. Average Daily Load Curve

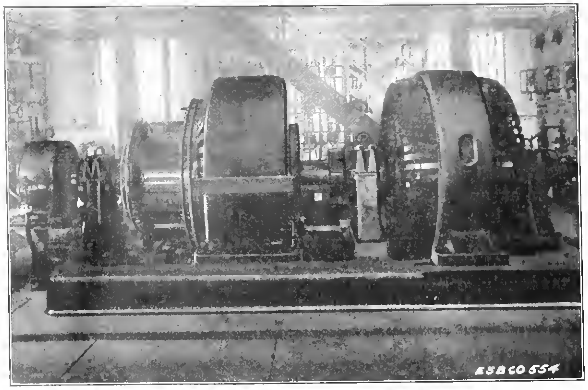

Fig. 6. Motor-Generator Set.

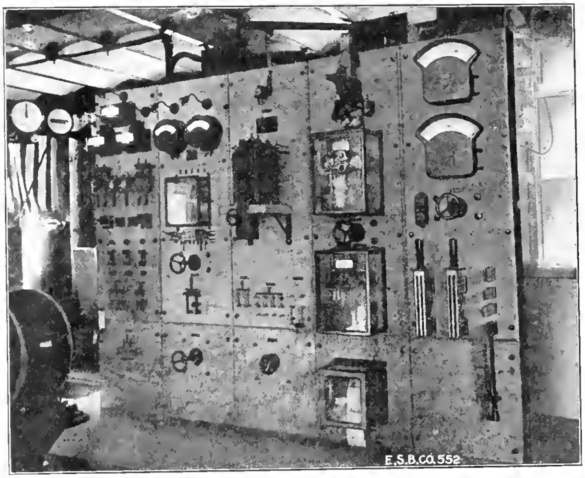

Fig. 7. Battery Switchboard.

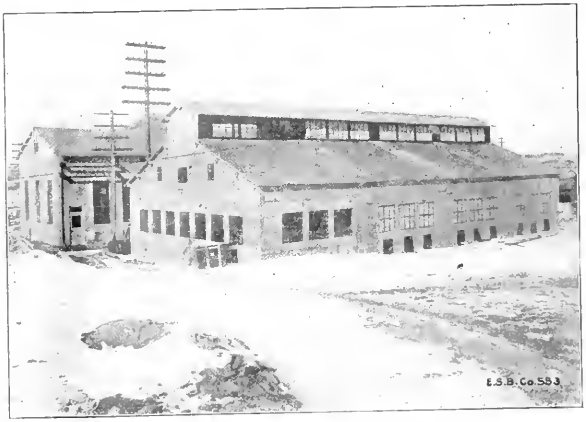

Fig. 8. Power House

chronous machine, while the energy components pass through to the battery.

The circuit breaker in the incoming supply line is equipped with time limit relays, both overload and reverse current, and is interlocked with the circuit breaker in the main bus bars, so that the battery apparatus is immediately isolated in case of failure of the power supply. The motor generator set, however, being still connected to the battery, remains in operation at approximately normal speed, and the emergency bus bars remain connected to its a.c. side. Whenever the main circuit breaker opens, it is evident that the carbon regulator must be cut out simultaneously, otherwise its action would at once tend to strengthen the field of the d.c. machine, causing the set to slow down. To prevent this, a small auxiliary switch in the carbon regulator circuit is attached to the main circuit breaker and opened at the same time. As soon as power comes on, the set is resynchronized without any interruption to service on those feeders which were connected to the emergency bus bars. For convenience and additional reliability, the main bus bars are all in duplicate, not shown in the diagram.

Graphic recording wattmeters, one on either side of the synchronous machine, show the regulated and unregulated load curves. Fig. 4 and Fig. 5 are sample records from these meters.

A photograph of the motor generator set is shown in Fig. 6. The d.c. machine is rated as follows: 1360 amperes output continuously at 250 volts, with frequent momentary inputs of 2720 amperes at 200 volts.

The battery switchboard is shown in Fig. 7. The reinforced concrete building, which houses the entire installation, is shown in Fig. 8, and the battery room interior in Fig. 1. The battery, consisting of 120 cells, each containing 35 plates, known as Type G, has a rated capacity of 1360 amperes for one hour, 2720 amperes for 20 minutes, or 4000 amperes momentarily. This latter rate exceeds the capacity of the motor generator, provision being thus made for the contemplated addition of a 250 volt d.c. ore haulage system, taking current directly from the battery. At present, the momentary fluctuations in the total demand amount to 400 or 500 kw., as shown on the graphic wattmeter chart, Fig. 4. These fluctuations are the result of the combined loads of several smaller hoists in addition to the two above mentioned. Following is a list of the present hoist motors, all of the induction type, with secondary control:

1 250 h.p.
1 150 h.p.
1 75 h.p.
3 50 h.p.

Total, 625 h.p.

The size of the battery was determined by the kilowatt hour capacity desired rather than by the monetary discharge rates. This is shown in Fig. 9, which is a fair sample of an all day average load curve. The full line represents the half hourly average as taken from the graphic wattmeter chart for February 26, 1910, and the dotted line represents the corresponding estimated future load. The cross-hatched portion represents the battery discharge in kilowatt hours necessary to obtain the best practicable load factor. An indication of the work done by the battery in carrying peak loads of this character may be obtained from the specific gravity chart, Fig. 10. Owing to the high rate discharges frequently required from the battery, its full 8 hour capacity is not ordinarily taken out. The available capacity for peak work is about 250 kilowatt hours, delivered on the a.c. side.

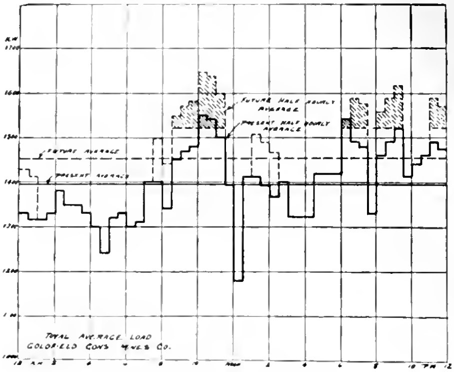

Fig. 10. Specific Gravity Chart.

On account of the maximum demand feature of the power contract, it is estimated that this installation will pay for itself in about two years by the saving effected in the power bills, without considering the advantages of direct driven electric hoists, of improved voltage regulation and of emergency service. Regardless of the power contract, even if the power company and the mining company were the same, the advantages of this installation, in improved service, would amply warrant the investment.

While similar systems have been applied elsewhere, as in the regulation of single phase railway loads, in iron and steel mills, etc., this is a pioneer installation in mining work and great credit is due to the Goldfield Consolidated Mines Company, and especially to Mr. J. R. Finlay, general manager, whose courage and foresight thus opened the way for the more extended application of electric hoisting.

We are indebted to the Electric Storage Battery Company of Philadelphia, the manufacturers of this installation, for the excellent data contained in this article.

ELECTRICAL SMELTING OF ZINC.

Elektrotermiska Aktiebolaget, whose works for refining and concentrating zinc ore are at Trollhattan, Sweden, is to increase its capital stock from $160,800 to $482,400 for the purpose of extending its operations. The production of this company in 1909 aggregated about 850 tons. The company has contracted with the board of water power managers for 10,000 electrical horsepower per annum for the years 1912, 1913, and 1914 at a price of $8.87 per horsepower per year. This 10,000 horsepower is in addition to the 7000 per year that the company has been using since 1910.

OIL BURNING.

(Continued)

BY. E. N. PERCY.

Having outlined in a general way the necessary procedure for the installation of an oil burning plant, directions will now be given for the actual installation so far as can be done on paper. With large plants it is usual to supply the main storage with swing pipe, heating coils, handling pump, and sometimes a special boiler for heating and pumping. Auxiliary to this is a small tank used for measuring purposes from which the burner pumps take their oil.

Heating coils are provided in the main storage in the measuring tank and in a special heater between the burner pumps and burners. All oil pipes should be carefully lagged with the best material obtainable. It should not be attempted to suck oil through long pipes, partly because of its viscosity and partly because of vapors which may rise from the oil just as steam rises from hot water, causing the pump to chatter without doing any work.

Where it is absolutely necessary a long suction pipe can be used if the lift be not more than 6 or 8 ft. by employing a 4 in. suction pipe inside of which is an 1¼ in. steam pipe discharging through a tee placed just over the tank. In such cases the pump should discharge into a small tank in or near the fire room from which the burner pump sucks, because the action of a long suction line is always irregular, causing unsatisfactory action of the burners.

Live steam should not be put into oil under any conditions because the water in the oil causes smoking and deposits of carbon. Live steam should always be used for heating oil, not exhaust steam.

Heating coils should be arranged so that the condensation will flow by gravity without interference to the terminal. At this point a riser may be used if necessary. Water hammer indicates that the steam is condensing more rapidly than supplied. The remedy is to gradually increase the supply of steam until it flows freely from the terminal. It must not be increased too rapidly or the water hammer will break some of the coils. A spiral coil in a circular tank is preferable to one made up of elbows because there is no water hammer in a well made spiral coil unless it has sharp turns.

The oil piping can be put in by any intelligent engineer. It should be put together with white lead joints as the oil tends to dissolve readily. Steam and oil piping should be carefully blown out with steam, otherwise the scale is likely to make a great deal of trouble by collecting in the small orifices of the burner. Valves of the type shown in previous articles will tend to prevent this.

Ordinary brick may be used for filling up furnaces and outside work, but the best grade of fire brick should be used for all interior construction, especially over the grates. Good fire brick costs from $25 to $50 per thousand.

The air for combustion should be regulated with the ash pit doors. The damper being left severely alone. When the fire is so regulated after being properly installed and trimmed so that a very little smoke shows at the top of the stack, it will be working most economically. The reason for this is that if a little smoke is showing there will be no excess air, and if there is not much smoke the trifling formation of carbon is negligible as a loss. It should always be remembered by the practical man that it costs as much to heat air as to heat water, and a clear stack is by no means a sign of economy and nearly always a sign of waste. It is easy to prove that if three or four times the amount of air is going through the fire than is necessary a loss of 40 or 50 per cent is taking place.

Everything should be provided in an oil burning installation which will tend to make the burner work with perfect regularity. An engineer having his first experience with oil, especially if the system is of his own installation, will find that the fire either puffs regularly with the strokes of the pump, or that it is extremely irregular and unreliable due to trouble in the suction line or to the gradual accumulation of gas in pockets where it cannot be blown off.

Furthermore, certain types of burners allow oil to collect in some pocket or spoon-shaped space near the orifice. After operating for a short time this body of oil will be ejected all at once, causing a puff and in severe cases blowing open the furnace doors. There is practically no danger with an extremely hot furnace but when a furnace is fairly cool and the burner has been running into it for some time without lighting, although there may be heat enough to generate a great amount of gas from this oil, then if ignition suddenly occurs from an incandescent surface or by means of a torch, the results can be serious.

The most economical flame is not a brilliant white which indicates excess air, but a deep heavy red bordering on smoking. This is on the assumption that the installation is correct and no air can enter the furnace except through the flame. Should the flame star, that is be full of bright white sparks, it is an indication that the oil is well heated. Starring indicates the formation of fine particles of pure carbon which burn with brilliant microscopic explosions. If a starring flame impinges upon anything quantities of carbon will be deposited, but so long as a starring flame does not smoke it is doing no harm. Sometimes a fire will be filled with heavy red sparks; this should not be confused with starring, and indicates imperfect atomization. The red sparks are comparatively large chunks of oil burning and smoking. Such a fire invariably deposits carbon and asphaltum. The remedy is to perfect the atomization.

When a fish tail flame is working near the surface of hot brick and happens to touch it instead of leaving the brick at the angle of incidence, the flame will turn up at right angles into the boiler, overheating it locally.

The horizontal conical flame should be looked upon with suspicion by the practical engineer for the reason that no matter what the form of the burner, the flame is not perfectly conical, the under side tending to rise toward the higher side, thus distorting the whole flame and leaving the bottom of the furnace clear for excess air to rush through.

Next to heating the oil and probably the most important thing is the arrangement of the draft. Every person is familiar with the absolute steadiness of the flame of a coal oil lamp, and is equally familiar with

the way it smokes and becomes unsteady when the chimney is removed or when the draft is shut off. The steadiness of the oil flame is due entirely to the draft being carefully distributed over its entire area, this being the secret of steady noiseless fires.

If, however, it is desired to have an intense combustion and high temperature concentrated in a small point, as for instance in a blacksmith forge, then the entire supply of air should be forced in with a blast at one point. On the other hand it sometimes happens, as in lime or cement burning, that it is desirable to have a very large soft fire of comparatively low temperature. This is accomplished by taking a part of the waste gases from the stack and mixing them with the in-going draft.

In making burners of any kind the orifice should always be finished as accurately and smoothly as possible. If a slotted burner, the slot should be milled, scraped, and brought down to a true surface. For a conical flame from a plain round orifice, the orifice should be reamed accurately to dimensions, as the least defect in this work will be magnified in the shape of the flame. When a fishtail flame issues from between two flat plates it is not so necessary to be accurate because the general average of the plates will hold the flame fairly well in shape; but when issuing from a slot in thin metal, the slot must be made very accurately indeed in order to have a well shaped fire.

Complaints arising from the oil being too heavy are entirely a matter of heating. There is no such thing as an oil that is too heavy if the heating equipment is ample and where the oil is criticised it is safe to assume that this is the trouble. Furthermore, the argument is sometimes raised that a refined oil has had the heat all taken out of it and, therefore, is not as good for fuel purposes. This is the veriest rot, because the exact opposite is the case for the following reasons:

As explained before, light oils have more heat per pound and less per barrel, and they are paid for by the barrel; heavy oils have less heat per pound but more per barrel. The light oil ignites more easily; it is less necessary to heat, but delivers less heat per barrel, and it should be remembered that oil is purchased by the barrel and not by the pound. To illustrate:

	B.t.u. per lb.	Weight per gal.	B.t.u. per gal.	B.t.u. per bbl.
23 Gravity Crude	17,712	7.63	135,100	5,774,200
22½ Gravity Crude	18,977	7.66	145,220	6,099,240
14.8 Gravity Crude	18,697	8.05	150,650	6,327,300
14.03 Refined	18,716	8.10	151,599	6,367,158

Refering to tests made by Professor Edmond O'Neill at the University of California the following results will be noted:

CALORIFIC VALUE OF PURE OIL OF DIFFERENT GRAVITIES.

Determinations by Professor Edmond O'Neill.

Degree Beaume.	B.t.u. per pound.	Weight per barrel.	B.t.u. per barrel
10	18,280	350.035	6,398,600
11	18,340	347.55	6,374,100
12	18,400	345.10	6,349,800
13	18,460	342.68	6,325,900
14	18,520	340.30	6,302,400
15	18,580	337.96	6,279,300
16	18,640	335.65	6,256,500
17	18,700	333.37	6,234,000
18	18,760	331.10	6,211,400
19	18,820	328.89	6,189,700
20	18,880	326.69	6,167,900
21	18,940	324.55	6,147,000
22	19,000	322.42	6,126,000
23	19,060	320.28	6,104,500
24	19,120	318.22	6,084,400
25	19,1[illegible]0	316.15	6,063,800

It will be noted that in these tests while a light oil shows more B.t.u. per pound it is less per barrel because it weighs so little, and the engineer should remember that he is buying by the barrel and not by the weight.

He should also remember the great necessity outlined in this article for heating the oil as he cannot use economical heavy oils unless prepared to heat them from beginning to end.

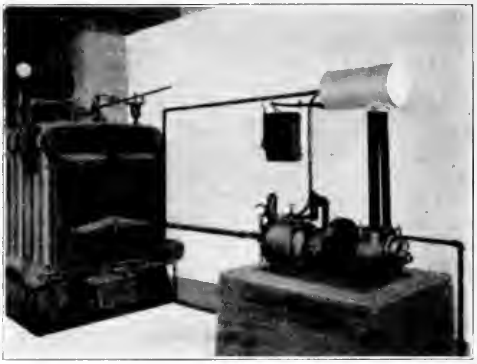

Fig. 93.

Figs. 93 and 94 are special types of burning equipments adapted to hot water boilers and house work in general.

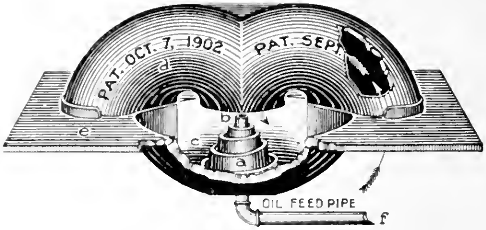

Fig. 94.

Fig. 95 shows a coil made from one length of 1¼ in. pipe intended, as a heater for heating a small tank or barrel of oil, or heating the oil in the immediate vicinity of a suction pipe in a very small plant. This type of heater is some times used to aid in the unloading of a car as shown in Fig. 96.

Fig. 97 shows a method of erecting and supporting heating coils intended to surround the suction pipe in very large tanks.

The purpose of showing these photographs and drawings is to give the practical engineer a visual idea of the general arrangement of oil burning installations as practical men learn more with their eyes than any other way.

Fig. 98 shows the arrangement of a Stirling boiler for burning both sawdust and oil. This is arranged for a local company who sometimes have sawdust to burn and sometimes not. The oil is burned either alone or with the sawdust and the plant has been found to operate successfully. Its success is due in part to the heat of the arch immediately over the oil which tends to keep it ignited, and the whole distrib-

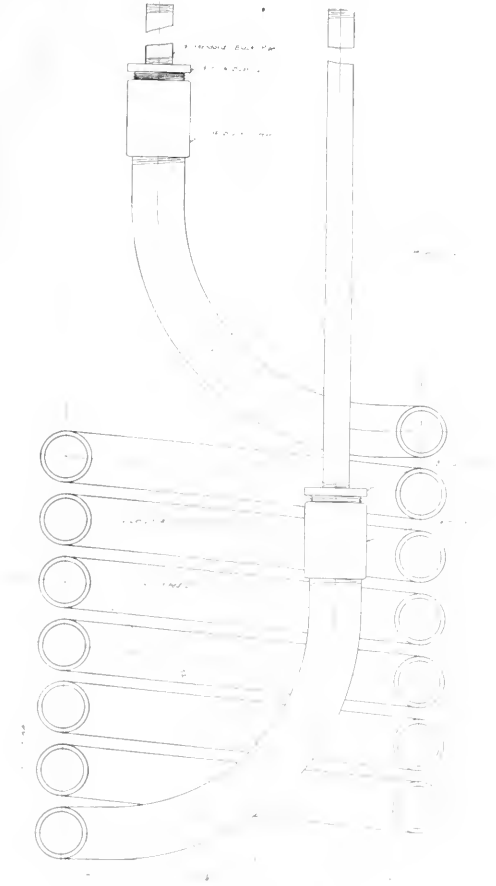

Fig. 95. Heating Coil Made From One Length of 1¼ in. Pipe.

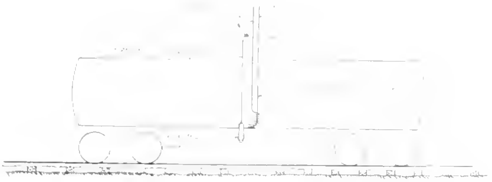

Fig. 96. Method of Unloading an Oil Car.

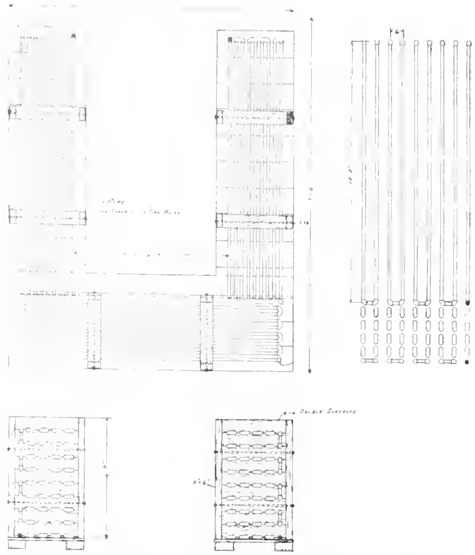

Fig. 97. Method of Erecting and Supporting Heating Coils.

Fig. 98. Stirling Boiler Arranged for Firing Sawdust and Oil.

uted draft coming through the grate bars. It should be mentioned that when a heavy sawdust fire is carried together with the oil, the upper doors are open slightly to furnish air exclusively for the oil.

Fig. 99 shows a small installation comprising a single acting pump, coil heater, and diaphragm governor for regulating the pressure. Some engineers do not like a single acting pump for oil work because it is not quite as reliable as an ordinary duplex. Perhaps it is not any more unreliable than a duplex in actual dependability, but when out of action it cannot be fixed by an ordinary engineer unless he happens to be an expert with the particular make of pump in question.

Fig. 100 shows a larger installation of the same character, having duplex pumps in duplicate and coil heater, diaphragm governor for regulating the pressure, and gas drum for entrapping oil gas. This drum should be blown from time to time. The piping is not as complicated as might appear, it being so arranged that the pump may be connected either to suck or discharge, the heater being cut out if desired. The main switch valves are for oil. Fig. 101 is a diagram giving complete explanation of all connections for this particular oil burning system.

Fig. 102 is taken directly from a catalog of a prominent manufacturer and is printed partly because it is a well known and successful type of burner and partly

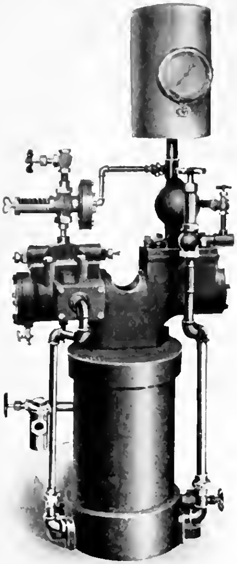

Fig. 99. Small Oil Burning Set

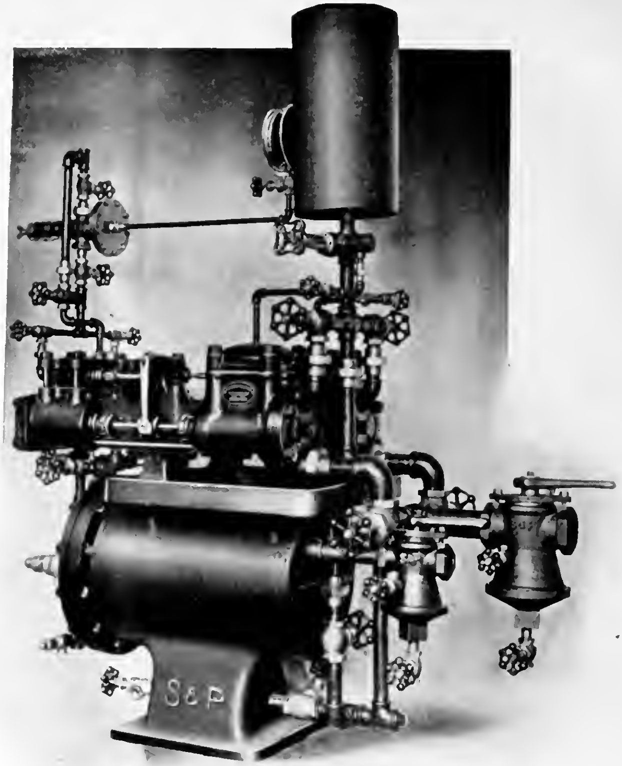

Fig. 100. Large Oil Burning Set.

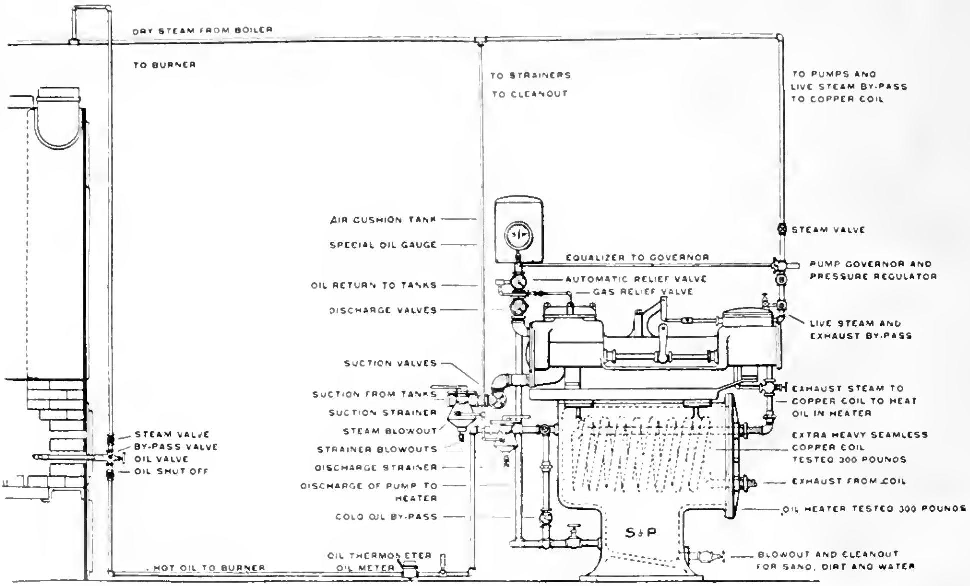

Fig. 101. Diagram of Connections.

because of the information for the practical engineer.

Fig. 103 shows the construction of the switch cocks manufactured and used by this firm and shown

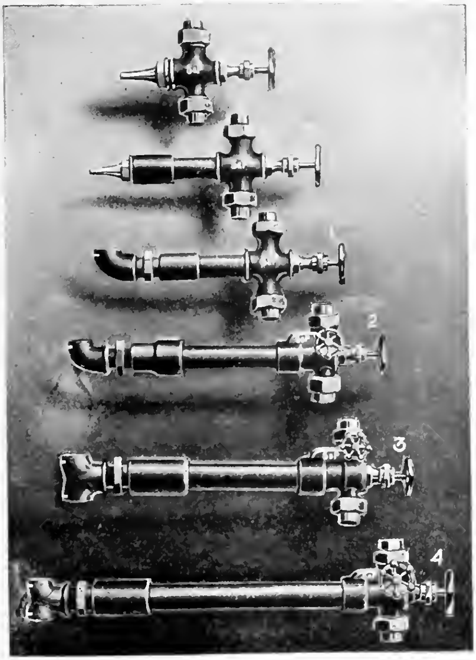

Fig. 102. Various Types of S. & F Burners.

No. 00. For Melting Brass, Copper, Lead, Etc

No. 0. For Melting Steel, Iron, Etc., Also for Heating Steel and Iron for Bending, Flanging, Etc.

No. 1. For Tempering, Forging, Annealing, Etc., Also for Brick and Lime Kilns, Etc

No. 2. For Bakeries, Ovens, Retorts, Heaters, Small Boilers Etc

No. 3. For all Standard Makes and Sizes of Boilers, Furnaces, Kilns, Etc

No. 4. For Large Boilers, Furnaces, Etc., in Genral.

in Fig. 99 in connection with the installation. It will be noted that there is a by-pass whereby the oil can be switched by for a few moments while the strainer is being cleaned—an excellent feature.

Having made every effort to explain clearly oil burning apparatus for steam plants to practical engineers, the next article will address itself to the same class of men on the application of oil to industrial work, such as cement burning, lime kilns, clay and pottery works, terra cotta, vitrified pipe, fire brick, red brick, copper smelting, reverberatory furnaces, glass works, crematories, and other uses.

(To Be Continued)

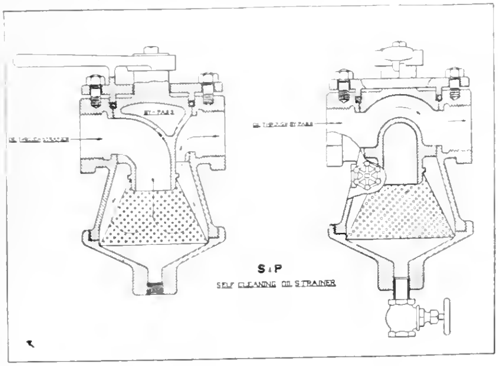

Fig. 103. Self-Cleaning Oil Strainer.

OIL STORAGE REGULATIONS AT PORTLAND.

An ordinance has been introduced at the Portland City Council providing that storage of explosive oils will be permitted only in warehouses and distributing stations built according to strict fire rules at least 500 feet from any dwelling and 2000 feet from the harbor line. A distributing station may consist of street storage tanks and one-story concrete buildings for warehouse purposes. The amount of oils allowed in storage at one time is limited to 15,000 gallons. All tanks must be built above the ground and surrounded by an earth embankment with a capacity greater than the capacity of the tank.

Fuel oils will be permitted in buildings only when storage tanks built to insure safety from fire or the accumulation of gases, are installed. Fuel oil may be delivered in steel or wooden tank-wagons or cars, and may be kept in the oil companies' distributing stations in quantities large enough to meet daily needs.

PUBLIC SERVICE CONDITIONS AT SEATTLE.

Public service corporations of Seattle have increased their efficiency in handling business in the last eleven years in a greater ratio than the increase in population, according to the annual report of A. L. Valentine, superintendent of public utilities. While the population in that period increased 199 per cent, the gas mains were increased 425 per cent. In the same period the number of street cars have increased 229 per cent and the street railway track mileage 193 per cent.

Despite the fact that the earnings of the Seattle Electric Company have decreased 4.6 per cent in the past year, the report shows that fifteen additional cars have been put in service.

The report sets forth that during the morning rush hours 255 street cars are used to handle the traffic. At noon but 175 are in use and in the evening 376. In proportion to population it is shown that Seattle has better street car service than does Cleveland, which has only 94 per cent of the number of cars in service during the rush hours and 76 per cent in the middle of the day.

To ascertain the exact character of service being rendered the public by the street car companies, 1826 checks were made during the year.

The report also holds out the hope that the Seattle Electric Company will soon reduce its rates in handling freight and parcels.

It is predicted that the municipal car line will be a great success and that it will also contribute towards the success of the city lighting plant by using a part of the day load.

THE SLIDE VALVE AND ZEUNER DIAGRAM.[1]

BY ROBERT SIBLEY

Having previously noted the fundamental laws of thermodynamics it will now be interesting to see the practical applications we have for these laws in the operation of the simple steam engine. It will first be instructive, however, to enumerate the names of the different parts which appear in the operation of the simple slide valve engine and consequently let us begin with the slide valve itself. In his excellent little treatise on the "Mechanics of Machinery," J. N. Le Conte of the University of California has set forth some simple ideas of the slide valve. In the considerations of this lecture our ideas are largely drawn from this little treatise.

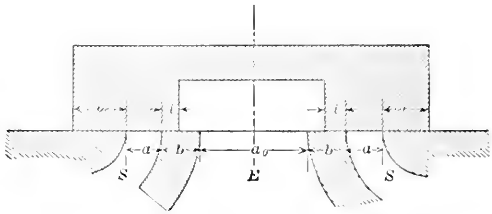

Fig. 34. Diagramatic Representation of the Details of a Simple Slide Valve.

In Fig. 34 we have a diagramatic representation of the simple slide valve. Steam is either admitted or exhausted in the cylinder through the ports S. When exhaust takes place the valve is either moved to the right or left so that an opening is made from S over into E thereby allowing the steam to escape from the cylinder. In the diagram the valve is shown in its central position. That portion of the valve shown at e is known as the outside lap, while that portion shown at i is known as the inside lap and a is the width of the port opening. It will be seen from the considerations of the Zeuner diagram that the proportions of inside and outside lap, together with the valve travel have very important relations in determining the steam distribution in the cylinder.

Before, however, considering this in detail let us see how in general the simple steam engine operates. In Fig. 35 we have diagramatically represented a steam engine cylinder with the piston over at the extreme right or what is technically known as the head end dead point. Beneath the representation of the cylinder is seen an indicator card, while to the left is a diagramatic representation of the crank arm and the eccentric arm. It is to be noticed that the crank and eccentric are turning in a counter-clock-wise direction. The long radial black line represents the crank arm and the short line the eccentric arm. The angle between the eccentric and crank arm is seen to be greater than 90 degrees, the amount by which this exceeds 90 degrees is known as the angle of advance and is usually represented by the Greek letter δ. In the position shown in Fig. 35 steam is being admitted from A through the ports into C which shows the piston head about to move to the left, thereby forcing out of D the steam which has been fully expanded in the stroke just completed, into the exhaust port B. The point at which the valve allows steam to enter the cylinder is known as the point of "admission." This operation continues until we arrive at the situation shown in Fig. 36 where it is seen that the

[1]This paper comprises the Fourteenth Lecture of the series appearing in these columns entitled "Primer of Applied Thermodynamics" which is a resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this journal before the Mechanical Engineering students at the University of California.

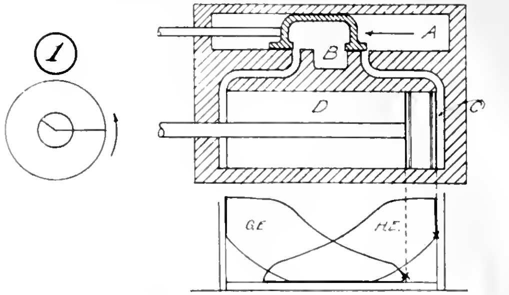

Fig. 35. Point of Admission of Slide Valve.

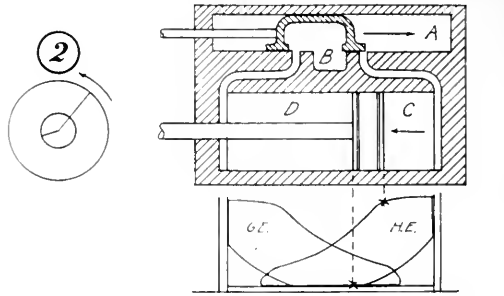

Fig. 36. Point of Cut-Off of Slide Valve.

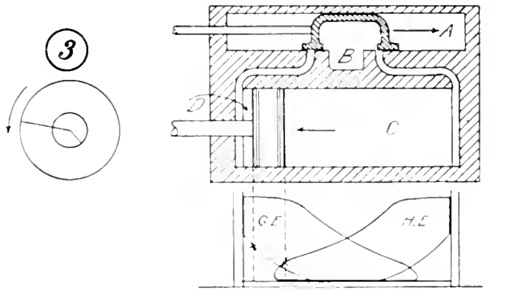

Fig. 37. Point of Exhaust of Slide Valve.

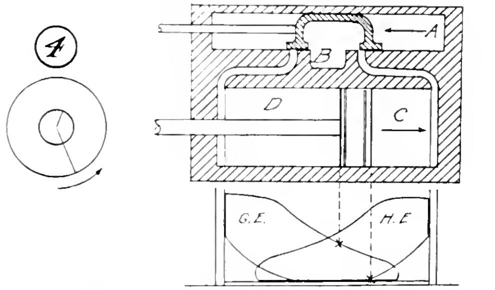

Fig. 38. Point of Compression of Slide Valve.

valve is just about to prohibit any more steam entering from A into C. This then is known as the point of "cut-off" and from now on to the end of the stroke, the steam derives its energy from its internal supply. Such an expansion we have seen in our last lecture is said to be adiabatic, but as a matter of fact due to the condensation of steam in the cylinder it approaches more that of isothermal expansion than that of adiabatic expansion.

When the piston head has arrived at D as shown in Fig. 37, the exhaust opens, as shown in the figure, so that steam is allowed to escape from C into B. This is known as the point of "cut-off" and it is evidently seen that the inside lap of the valve is a determining feature for this constant of valve operation. The piston head having reached the end of its stroke now returns to the right and when it has arrived at

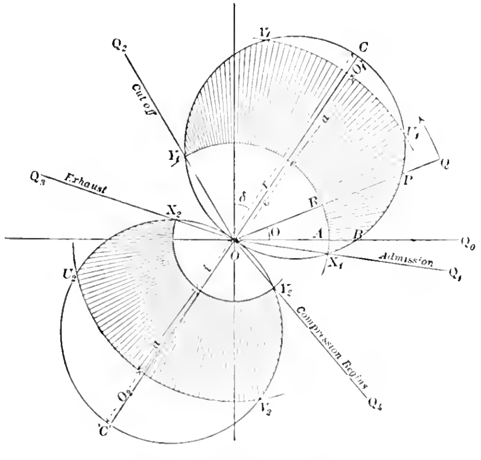

Fig. 39. The Zeuner Diagram.

the point shown in Fig. 38, once again it is seen that the valve prohibits steam from escaping from C into B, nor can it escape into A, therefore we have a compression of the steam which has been cooped up in the cylinder. This then, is known as the point of "compression."

It is plainly seen from the diagram that the relationship of these four constants, namely the point of admission, the point of cut-off, the point of exhaust and the point of compression, is most vital in the successful operation of the steam engine and it is the study of the simpler relationships with which we are concerned in this lecture.

It is shown in works of mathematics that the constants of the valves above set forth are related as shown in Fig. 39. This method of representation is known as the Zeuner diagram. It is seen that the outside lap, inside lap, angle of advance and throw of the eccentric which is usually represented by r, the same being one-half the total valve travel, determine completely the point of admission, cut-off, exhaust and compression and it is seen that when certain of these constants are given us we can at once determine the other constants of the valve.

It is seen that the valve of the steam engine performs the function of admitting steam alternately into the ends of the steam cylinder, and of exhausting the same into the atmosphere. Since the laps are put upon the slide-valve as shown in Fig. 34 to work the steam expansively, thus drawing from the steam itself every bit of stored energy possible, the laps may or may not be the same at the two ends.

In most engines, especially those designed for high speed, it is desirable to have the steam enter just before the piston is ready to start on its return stroke in order that steam may be fully admitted at the beginning of the new stroke. The amount the

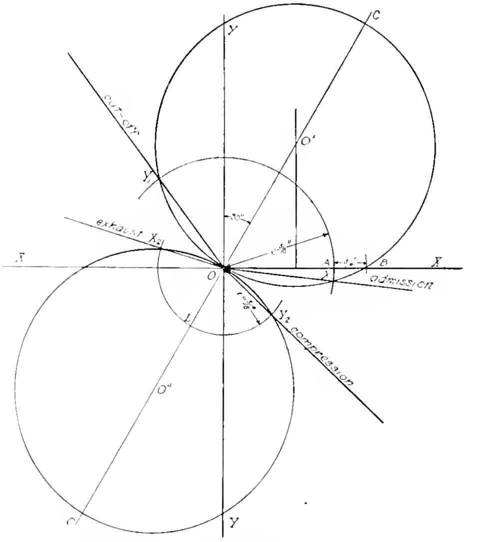

Fig. 40. Illustration of Problem Computation by Means of the Zeuner Diagram.

valve is open at the beginning of the stroke is known as the lead and is denoted by v.

Since it is seen that the four crank positions cannot be taken arbitrarily due to their inter relations one with the other, let us take a simple example and apply the Zeuner diagram to its solution. In measuring the constants of a certain slide valve engine it was found that the outside lap of the valve measured $\frac{5}{8}$ in. the inside lap $\frac{3}{8}$ in., the lead 3/16 in. and the angle of advance was found to be 30 degrees. Looking now for an instant at Fig. 40, we see that by drawing a horizontal line XX and a vertical line YY, we can easily construct a Zeuner diagram and find the points of admission, cut-off, exhaust, and compression, and also find the throw of the eccentric r. Thus I describe X_1AY_1 with O^1 as a center and radius $e = \frac{5}{8}$ in. I then lay off the lead AB equal to 3/16 in. Again I describe a circle X_2LY_2, with radius $i = \frac{3}{8}$ in. The line C O C is made so that an angle of 30 degrees which is the angle of advance is made with the vertical line Y O Y. I erect a perpendicular bisecting the line O B and intersecting the line C O C at O^1. With O^1 as a center a circle is now described passing through O and B, also a circle with the same radius and center

at O" is described. I at once have the point of admission at X_1, the point of cut-off at Y_1, the point of exhaust at X_2 and the point of compression at Y_2. I scale off C O which is the valve travel. So that the Zeuner diagram is most practicable and useful.

There are many other useful applications of the Zeuner diagram. In the design of the proportionate parts of the slide valve it plays a most useful role. The student is advised to try the solution of the following and thus become accustomed to this method of valve analysis.

Thermotwisters.

1. In a slide-valve it is found that the inside lap measures 5/16 in., the outside lap, 7/16 in., the lead 1/8 in., and the cut-off is 5/8 in. stroke. Construct a Zeuner diagram, showing all the other valve constants.

2. Sketch an indicator card for the above engine, assuming boiler pressure at 100 lb. gauge, and the engine stroke 12 inches.

THE COST OF DOING BUSINESS.[1]

BY B. E. FANNING.

For the past two years I have had under way a careful investigation of the Electric Business in general from the contracting point of view. I have found this investigation to be an exceedingly interesting study. Any industry of any proportions will permit of an analysis; such analysis will evolve the theory of business; and this theory will outline the systematic and scientific manipulation of the capital invested. There is an underlying basic principle, so simple that it will appear almost foolish for me to mention it. It is this: manipulations are either a success, a failure, or mediocre in their results. Your methods and your policies of business are right; or they are wrong, or they are passing medium. One of these is inevitable.

Business is not a hap-hazard, harem-scarem business that many of you know. It is not a business for the hands and the feet and mouth. It should appeal to and call forth an entirely different part of man. It is a work for the brains, for the ambition, for the energy. How often we are greeted with the watch word "Well, how is business?" It is no better nor any worse than you make it. By the inevitable laws of cause and effect, it is just exactly what you make it. It cannot be one whit better; it is not an iota worse. I hear many of you complain of business conditions. Do not kick at them for they are not to blame; they are the inevitable effect; you are the cause. You are the one to change. "Know thyself and stand before kings."

How would you begin to know your business? You deal in two commodities, "Labor and Material." You purchase them in the best market. You know exactly in dollars and cents what you have to pay for them. Granted that your knowledge of these matters is perfect; for these are only preliminaries. You are called upon to estimate upon prospective business; and what do you do? Do you make as thorough an investigation as the proposition demands? Do you conceive exactly what is wanted and exactly how to do it? Do you figure each foot of the wire, loom, conduit, moulding; each fitting, and each accessory? Is your conception before hand, what the finished work will be afterward? Have you allowed for all the unforseen difficulties and long chances? Well, granted; for these are still only preliminaries in business. By this method you arrive at the exact cost in dollars and cents, of your two commodities, "labor and material"; and now what? You have now arrived at your great problem. You are now at the point so faithfully portrayed by that famous cartoon of an electrical contractor, "What did I forget?"

Gentlemen, here is a business, for no preliminary artist. This is a main event. I will tell you what you forget; the very things that prompt you to leave the ranks of the wire-man and the helper to launch into business. You forget the part that you should play in that great body; civic, social and commercial; from which you draw your sustenance, and to which you should contribute your part. Remember that you are receiving civil protection and civil privileges for which you must pay in the form of U. S. Revenue tax, State Corporation tax, County and City Personal tax. Remember that there are social movements conceived and fostered by your commerce chambers, which require your financial and moral support. Remember your social clubs, your National Association, your Local Association, all striving for your best interests and worthy of your aid. You should be mortified to be the drone to stand back from any cause whatsoever and see your neighbor in business put his shoulder to the wheel in the interests contributing to your progress. And, believe me, gentlemen, you will be pinched and starved by your own inertia in these matters. Launch out and take your place among men of affairs, for it is your birthright in so far as you will appear to grasp it.

Further, you forget that you have an establishment to maintain. Rents, telephone bills, light bills, and other absolutely necessary bills come each and every month. Fixtures, sales equipment, construction equipment, factory equipment, are the breath and energy of your business. They are to your business what costly apparel and reputation and prestige are to man. Why do your business neighbors install marble stairways, fixtures, elaborate display in electric lighting when it all swells the fund of over-head expense? Do you expect them, in a business way, to be the good spender to cast pearls in your way, while you knowingly, or otherwise play the part of the piker? No, you are judged by your overhead and those elements contributing to it. I am not touting a business fop or a snob. There are inflated overhead expenses everywhere. They are diseased overheads. But I speak of overheads that are the product of the finer business understanding based upon knowledge of all the elements of human nature that contribute to business life.

You still forget. What protections have you placed on your commodities? Fire insurance, and life insurance are necessary in your home. Why should they not be put in your business? We have with us today representatives of the jobbing interests. Did any of them ever ask you if you carried fire insurance, life insurance, employee's liability insurance? No? Well, we do; whether they know it or not; whether they have ever thought of it as being a protection to their interests; we have felt it necessary to draw this bulwark of strength and protection.

You still forget. Have any of you ever lost any

[1] Address before California State Association of Electrical Contractors' 1911 Convention at Santa Catalina Island.

money? Have you ever had to make improvements, extensions and repairs? Have you money invested that might make good interest for you if placed elsewhere? Your losses, improvements, interest, and repairs flow into this overhead expense.

There are many electric contractors who do their own work, and therefore figure that they have only a light overhead expense. I would not for the world speak discourteously nor disparagingly of your efforts and your business. Personally I am far more liable to rap the man who has not learned his business through the soiled hand route. In the first place, you have a greater percentage of overhead expense than the contractor who only handles his business. Mind you, I am not speaking of diseased overheads. Tell me—How is it possible for ten wireman contractors to reduce their separate overheads to the same percentage on the aggregate of business done, as that per cent of overhead of one electric contractor handling the same amount of business as the ten? It is not reasonable: the great basic principles of economy in overhead expenses lies in the combination of interest. Every minute of your time that is spent, and on which there is not a set price of return to you, is a portion of your overhead expense, in the same amount that this effort would cost you in open market. It matters not where the hands of the clock stand; an effort costs you as much at 12 o'clock at night as it would at 12 o'clock at noon. Every cent spent for which there is no set price of return is also a portion of your overhead expense. At the end of the year when the total of your efforts are considered, when you separate the wheat from the chaff, the wire-man contractor will find that the chaff will form considerable percent of the product at hand. (I will quote statistics on this later.) In the second place tell me how is it possible for you to accumulate a fund for an overhead expense, unless you figure it in every business transaction as you go along?

A contractor who has an overhead successfully in operation does not need to figure a starting load at all, but only the running load. I say to you all, who are flinching at your overhead expenses, who do not feel the value of the overhead or the necessity for it, take a brace. It is the protection, the strength, the energy, the ambition, the intelligence, the life, and the soul of your business.

Recent reports of the National Association show firstly that the percentage of overhead expense runs inversely with the amount of business. They show secondly, that there is an average overhead expense of approximately 20 per cent.

Now there is no good reason why any of you should consider a lesser percentage than 20 per cent as a consistent rate of overhead.

Lest you still forget, there is yet to be considered the one-tenth tithe. No enterprise of the proportions of an electric contracting business should be satisfied with less. It is barely good interest upon good security. It is now absolutely necessary in continuing with our problem of estimating, for us to consider not only initial cost of your two commodities "labor and material," but also the additional cost of your overhead expense and your profit. Starting with the cost of your commodities as the known factors in the estimate, what will you add on? Some of you add on ten per cent and hesitate, watching developments; a few of you add on twenty per cent and hold your breath; a very few add twenty-five per cent and feel like a trust. Gentlemen, to cover a twenty per cent overhead and ten per cent profit, there is no rule in arithmetic or law in figuring that will permit you to add a lesser per cent to the costs of your commodities than 42 6-7.

Still there are those among you who figure your work "below cost." There are those among you who honestly agree to take your work for "Cost" plus ten per cent." There are those among you who take contracts "below cost" to get the fixtures, to get the extras, to get the future business, to keep some other contractor from getting the job. These are but mere tricks of the game and such demoralizing influences are not fit for this nor any other business. Any person grown to the age of a full sized man, who knowingly or otherwise, figures his work to lose money, who deliberately takes the chances of a gambler, only to make up the lost change from his invested capital, as a business man is an enigma, and beyond my understanding.

Now speaking of costs, how many of you have a system that shows you the real old hard cash (dollars and cents) cost on any process or transaction? What actual foundation have you for your Estimating Costs, as determined from your "Real Costs?" What does it cost to sell a socket, to install a fuse, to wind an armature; to sweep your floors, to run your errands, to keep your books? Do you know at any time(and all times) where any cent (or every cent) is spent, and the value of such expenditure? Does your system have sense enough to show where every cent is all the time? Does it show cost to the cent on every transaction and process of your business? Gentlemen, I can state that you can easily keep such a system for $100,000 business with one stock boy, one bookkeeper, and one stenographer. It would indeed be a pleasure to me to show you how simple it is to keep such a system, but that is a matter of detail only.

Our great crying need in the Electrical Contracting business or any other business is for men, faithful, conscientious, energetic, ambitious men. Such men are not made; they are born. Give me the man who, as a boy, carried a broken slate; who wrote the capitals as well, when he was only asked to write small letters; who did the chores, morning and night, and felt the responsibility of them. Give me the man, whose knowledge is self-earned, resting upon the firm foundations of youthful training, who has the courage of his convictions to call a spade a spade, whose actions of today can be depended upon tomorrow.

Confidence will be the key-note of your success in an attempt to raise the standards of the Electrical Contracting Business; and the vehicle of this confidence is the association. Confidence comes with understanding of what the other fellow is doing and the association is the medium for acquaintanceship among fellows. It is the medium of interchange of ideas. The organ for adapting methods. It should be as a school for instruction, a tower of strength in the uplift of the Electrical Fraternity.

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POWER AND GAS

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Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas" Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

That J. P. Morgan has taken ten million dollars in Pacific Gas & Electric bonds is doubly significant, exhibiting this financier's confidence in the stability of Western progress in general and in hydroelectric securities in particular.

By his fortunate escape from death by electric shock, H. C. Inman, foreman with the Portland Railway, Light & Power Company, confirms the contention that fatality is dependent not so much upon the voltage as upon the path of the current. In other words the current did not pass through a vital part, though the voltage was 11,000.

In this day of scientific economy it seems strange that the officials of the Los Angeles Gas & Electric Company should suffer a police court fine because of smoky stacks. It needs not the decision of the Superior Court as to the constitutionality of the smoke ordinance to convince an unbiased engineer of the wastefulness of insufficient combustion made evident by clouds of black smoke.

The finance committee of the Los Angeles City Council has recommended that the municipality's public utilities board surrender its power to the new California Public Service Commission. The arguments in favor of this move are so many and those opposed so few that but little difficulty should be experienced in inducing the voters to transfer these important duties.

It is doubtful whether even the most radical of water power conservationists will indorse the opinion of a prominent Pacific Coast oil producer that the use of electricity in developing petroleum is not conducive to the best interests of the industry, because fuel oil is competitive with hydroelectric power. As a means for equalizing production and consumption this method would prove as ineffective as it is foolish.

The old adage of an ounce of prevention being worth a pound of cure does not hold true in the case of protecting wooden piles from the home-making propensities of teredos and other marine borers. The various preservative treatments merely postpone the day of tendability, where as recent experiments at Seattle have demonstrated that an electric current of high amperage and low voltage will poison these pests by liberating large volumes of chlorine as the result of electrolysis.

At Butte, Montana, the past year has witnessed marked reductions in the cost of producing copper by the scientific application of power. A saving of from one and a half to two cents a pound has resulted from the substitution of compressed air for steam hoisting of ore and the use of electricity in underground pumping, haulage and ventilation. In the opinion of the State mining inspector this should prolong the effective life of the camp at least twenty years, as the lower grade ores can now be mined at a profit. Thus is electricity repaying the debt it has long owed mining.

Turning the Leaf

Gone! Gone forever! Like the rushing waters another year has spent its force in driving the eternal wheels of time and hurried on its way to the ocean of oblivion. One more click has been registered by time's infinite meter, whose gears turn not backward and whose dial has no limit. The old year is thrown on the scrap-heap of the ages and a new one is installed in its place. Yet the energy of this old year transmitted to the distant future will be the motive power for new achievements in the world of progress.

These mutations of time we think about and commemorate, forgetting that there was no old year and is no new, that time is but an arbitrary measurement of duration, that what we call marks on its dial are the veriest figments of our imagination, and merely enable us to mark off that transient piece of the ceaseless stream with which we are momentarily in contact.

The year to come differs no more from the year that is gone than do two ticks of the same clock; they are only two atoms of time. This new year will be like other years, with their complements of success and failure, hopes and disappointments, joys and sorrows. From the hour we greet it with "Hail" to the day we say to it "Farewell," we will only repeat the song of the ages, which no man has yet understood.

The Public Be Pleased

The time honored or time dishonored expression heading this editorial, first brought to life by the elder Vanderbilt, as alluded to in the recent remarks of Glenn C. Webster before the electrical men at San Francisco, California, has certainly softened in recent years to the more highly euphonious terms "the public be pleased."

And well it may.

The highly centralized and specialized mode of modern life, both in business and in the home, make a perfectly oiled industrial mechanism imperative. Let little Willie awaken without the heat and water to supply the "inner boy" and whoever said that the place of torture set aside for the wicked in the next world was the worst imaginable will soon revise his ideas. Let the pulse of the great city cease its transportation throbs, or cut short its arteries of supplies for one brief month and it is beyond human intelligence to predict the result.

And so it is that when the very life and welfare of men are so dependent upon the great utilities, it behooves those serving the public to lend an attentive and reasonable ear to just demands and complaints.

It would seem hard to have fairer, more intelligent men at the helm of our Western corporations. Though not generally known, statistics which have been carefully and quietly collected to compare the proportion of complaints, for instance, in our mercantile establishments as compared to those registered against the corporations now so prominently in the public eye, are most flattering to the latter class. The honor then would seem to be due to the painstaking care with which our Western public service corporations are endeavoring to live up to the new golden rule "the public be pleased."

A Harmonious New Year

Co-operation has been tried and found wanting as a panacea for business ills. It is under the bane of the Sherman law, and until that dull instrument is either sharpened or discarded the co-operator must remain under the glance askance. Like destructive competition, constructive co-operation has proved inadequate. Why? The theory of co-operation requires that everybody get together. In practice some are left out. Its fallacy lies in its exclusiveness.

In the electrical business there have been organizations of manufacturers which did not include jobbers; associations of jobbers, which did not contain contractors; federations of contractors which did not recognize others and agreements among all these which did not seek public confidence. Public participation is the one thing that is lacking to raise co-operation to the higher plane of harmony.

Harmony is all-inclusive and has a deeper and more essential meaning than co-operation. It seeks the good of all concerned, whether supplier or consumer. Once its spirit is thoroughly infused there will be no need for the Sherman or any other law, as all will be working for the common welfare. Aptly designated as "the strength and support of all societies" we would especially recommend harmony to the consideration of the newly formed Electrical Development League.

Some More Arithmetic

He who delights in the fallacies and fancies of mathematical recreations and pastimes is often overcome with the apparent complete proof of some mathematical law which goes to demonstrate the very opposite of what he knows to be the truth. The young college chap goes home on a Christmas vacation and proudly proves to father on New Year's Day that there are two ducks on the plate instead of one. The old man is overcome with the logic, yet his forceful answer is to help himself to the only duck and invite his son to take the other.

And so it is in the every day run of life.

The Southern Pacific Company which is spending its thousands in furnishing its library cars with everything that goes toward boosting the West will be repaid many times over for its consistent efforts though at the start the contrary may seem more likely to happen. A systematic education does more for the upbuilding of an empire than any other factor in its growth.

The Journal feels flattered that it has been accorded the privilege by the Southern Pacific Company to assist in this educational campaign by having its pages open to the thousands of tourists on all Southern Pacific trains seeking opportunities in the West. One of the greatest assets of the West is its enormous power possibilities. The great international exposition of 1915 will exploit these human projects in embryo and if we shall be able to contribute our mite toward establishing commercial supremacy for the West our little problem in arithmetic which we have worked upon now for these twenty-five years will have been successfully solved.

PERSONALS.

W. W. S. Butler, manager of the Stockton Gas & Electric Company, of Stockton, is at San Francisco.

C. D. Garcelon, head of the Link River Electric Company, of Klamath Falls, Ore., is at San Francisco.

Frank P. Dunn and J. R. Duffy of the Bay Cities Home Telephone Company, were at Los Angeles during the past week.

K. G. Dunn, electrical engineer with Hunt, Mirk & Company, has returned to San Francisco from a business trip to Portland.

W. M. Wells, assistant engineer of the Oregon State Railroad Commission, has resigned to take a position with the California Commission.

William C. Faber, formerly with the Commonwealth Electric Company, of Chicago, is now with the power contract department of the Great Western Power Company at San Francisco.

S. L. Shuffleton, of Stone & Webster, has arrived at San Francisco from Fresno. His firm has supervision of an important development on Big Creek for the San Joaquin Light & Power Corporation.

R. J. Chapman, formerly manager of the Fowler Utilities Company at Fowler, Indiana, is looking over the power and light field on the Pacific Coast with the idea of making permanent affiliations there.

A. F. Hockenbeamer, vice-president and treasurer of the Pacific Gas and Electric Co., is at New York where he concluded the arrangements for the sale of $10,000,000 of the Company's bonds to J. P. Morgan.

P. D. Fraser, formerly sales engineer with the San Francisco office of the General Electric Company, is now with the company's Portland office, where he will continue to make a specialty of high tension equipment.

Elam Miller has resigned as commercial engineer of the Pacific Telephone & Telegraph Company to accept a position with the American Telephone & Telegraph Company in New York. C. P. Morrill has been appointed to succeed him.

D. C. McWatters, vice-president of the corporation representing the Kuhn interests in Idaho, is at San Francisco. This Pittsburg syndicate is now making a prominent feature of supplying electric power for heating purposes in Idaho and elsewhere.

Paul Lebenbaum, electrical engineer with the Southern Pacific Company at Portland, spent the past week at San Francisco arranging for papers to be presented at the Pacific Coast meeting of the American Institute of Electrical Engineers at Portland in April.

Fred L. Webster, Pacific Coast manager for the Allis-Chalmers Company, returned to his San Francisco headquarters during the past week, after visiting the factory at Milwaukee. The company's office has been removed to the ground floor of the Rialto Building.

Louis C. Kelsey, of Portland, Ore., has been employed by the Oregon State Board of Health to prepare a report and estimates on cost and results of constructing a gravity water system from Clear Lake in the Cascade Mountains to the state institutions at Eugene and Salem and for providing adequate water for the cities and towns from Eugene to Salem.

Wynn Meredith, Pacific Coast manager for Sanderson & Porter, of New York, who has returned to his San Francisco office from British Columbia, announces that the lowest bid on the new water works system for the city of Victoria was that of the Westholme Lumber Company, amounting to $1,169,720. Their bid was for a reinforced concrete conduit flow line and included, also, the steel pressure-pipes, dams, reservoirs, etc., and all of the work.

IN MEMORIAM.

Daniel Carroll Hemingray, secretary and treasurer of the Hemingray Glass Company of Covington, Ky., died December 14, 1911.

TRADE NOTES.

Stone & Webster Engineering Corporation announce the change of their offices from East Water and East Taylor streets to room 613 Lumbermen's Building, Portland.

B. A. Hansen, assistant engineer for the Evans-Dicksen Company of Portland and Tacoma is superintending the installment of the street lighting system, at Pasco, Washington, for which the above company has the contract.

The Standard Underground Cable Company has been awarded the contract for furnishing underground cable required for use of the San Francisco Department of Electricity during the current fiscal year, and also cable required in the construction of underground conduit on Polk street for the fire and police signal system.

Work is being rushed on the erection of the Pacific Gas & Electric Company's Curtis turbine generating sets at Station A., San Francisco, and at Station C, Oakland. Sixteen carloads of parts for the 15,000 kw. turbine for the former station arrived during the past week. Hunt, Mirk & Company have a number of men installing the Worthington surface condensers at both stations. The condenser base of one of these turbines weighs 75 tons.

The Fort Wayne Electric Works furnishing the switchboard and control apparatus for the Southern Sierras Power Company to tie in and operate their new transmission line with that of the Nevada, California, Power Company, at Bishop, Cal. The Southern Sierras line, which is to be 27 miles in length, is designed to operate ultimately at 150 000 volts and the potential transformers, etc., are built to operate on this voltage. The switches will be air-controlled and a small Ft. Wayne air compressor, motor driven, together with an air receiver is being furnished under this contract.

R. B. Elder, Pacific sales agent for The Ideal Electric & Manufacturing Company, reports the following recent sales: A complete induction motor equipment for the new shops, on the Oakland Estuary, of the Atlas Gas Engine Company; motor equipment for the shops of the Fess System Company, also the Pacific Gear & Tool Works; the installation in the new Pantages Theatre of two 175 r.p.m. special fan blower motors; a ten ton crane equipped with three slip ring motors for the Best Gas Traction Company, also an order from this company for twenty-five equipments for their new combined harvester, each equipment consisting of a 20 kw. generator, 15 h.p., variable speed motor and 7½ h.p., induction motor with controllers; twenty Type "A", 3 phase, 220 volt induction motors to the Mare Island Navy Yard, ranging in sizes from 1 to 20 h.p.; Nevada Petroleum Company, a 75 kw., a.c. generator equipment.

GENERAL ELECTRIC COMPANY IN NEW OFFICES.

Beginning with the first of the new year the San Francisco offices of the General Electric Company will be situated on the seventh and eighth floors of the Rialto Building at New Montgomery and Mission streets. The new quarters are more commodious and convenient than those which the company has occupied in the Nevada National Bank Building for the past five years and this change reflects the tremendous business strides that this company has made on the Pacific Coast during this period.

REMOVAL NOTICE.

On and after January 1, 1912, the Fort Wayne Electric Works and Sprague Electric Works of the General Electric Company will be located in their new offices, Rooms 301-313 Rialto Building, San Francisco.

INDUSTRIAL

NOTES ON ELECTRICAL DEVELOPMENTS FOR 1911—GENERAL ELECTRIC COMPANY.

Electric Railway Development.

The past year has witnessed much activity in the increase of equipment by electric railways in all sections of the country, the electrification of steam railroad lines and the development of electric railway apparatus. Of particular interest is the marked tendency towards the replacement of existing power stations having units of small capacity with centralized power plants containing large Curtis turbine units. On the Pacific Coast the United Railways of San Francisco have installed a 9000 kw. Curtis turbine unit to act as an auxiliary to the water power system of the San Francisco & Sierra Power Company. This is the second unit of this type and capacity which this company has installed.

The tendency towards the installation of large units noted in power station construction, also extends to the substations. These include six 1000 kw. G. E. motor generator sets for the Portland Railway, Light & Power Company, one 1500 kw. motor generator set for the United Railways Company of San Francisco, one 1500 kw. rotary converter for the Pacific Electric Railway, of Los Angeles, and five 500 kw. 1200-volt rotary converters for the Oregon Electric Railway of Portland.

The gratifying results secured with the use of General Electric commutating pole railway motors has resulted in placing of large orders for this type of motor, both for the equipment of new cars and the replacement of older type motors. Among other important installations were fifty 70 h.p. four-motor equipments for the Pacific Electric Railway, of Los Angeles, eighty 50 h.p. four-motor equipments for the United Railroads, sixty 50 h.p. two-motor sets for the Oakland Traction Company, and 130 70 h.p. two-motor sets for the Portland Railway, Light & Power Company.

Perhaps the most important development in electric railway apparatus that has been made during the past year is the G. E. "light weight" railway motor. A 50 h.p. G. E. "light weight" motor weighs 750 lbs. less than motors of the same capacity now in general use.

During the past year a number of steam railroad companies have either commenced operation of electrified lines, or have placed orders for additional electrical equipment. In June the Southern Pacific railroad commenced the operation of its electrified suburban lines in the vicinity of Oakland, Cal. These lines are operated with the 1200-volt direct current railway system—the initial installation including sixty-five motor cars, each equipped with four G. E.-207 (125 h.p.) motors and Sprague General Electric type M control. The overhead trolley system is used, current being supplied by twenty 750 kw. G. E. rotary converters connected two in series.

1200-Volt Direct Current Railway System.

A number of interurban railway companies have during the past year installed 1200-volt direct current railway apparatus. The Oregon Electric Railway, of Portland, Ore. (now operating some seventy miles of road), has recently placed orders for the necessary equipment to change to the 1200-volt d. c. system. Some seventy miles of additional road will be built and equipped with this system.

Rheostats and Controllers.

A complete line of theater dimmers has been developed and a number of these devices are now in successful operation. The CR-128 automatic starters for slip ring induction motors have been redesigned. Several interesting installations of controlling devices for use with motor operated fire pumps have been made. This controller consists of a totally enclosed combined automatic and hand-operated rheostat and a panel on which are mounted line switch, circuit breakers, contactors, and indicating lamps.

The first a. c. motor and controller for operating a large newspaper press was installed for the Knickerbocker Press, Albany, N. Y. It is a two-motor equipment consisting of a 50 h.p. slip ring type of induction motor and a 7½ h.p. induction motor of the squirrel cage type. The control is entirely automatic and operated by means of push button stations at various places around the press.

A liquid rheostat has also been developed for controlling alternating current motors used in connection with mine hoisting equipments. It consists of stationary electrodes assembled in a suitable tank, the resistance variation being obtained by varying the volume of the conducting liquid between the electrodes. Means are also provided for cooling the electrolyte.

Motors.

Many improvements have been made in the mechanical features of the open type mill motors, slow speed d. c. crane motors and the close-coupled type of two-bearing motor generating sets.

A unique type of G. E. single-phase alternating current linotype outfit has recently been standardized for commercial operation. Motors are provided with split phase windings, consisting of two sections, the first being used to obtain the requisite starting torque, the second becoming active only when the motor has attained full speed. The motor is arranged to slide laterally in its bearings a short distance, the core being displaced from the field in the starting position. Two carbon brushes resting on a collector ring complete the circuit of the starting section of the motor winding. The motor accelerates automatically without the use of external starter and centrifugal device.

The General Electric Company has recently placed on the market a new line of polyphase varying speed exhaust sets having a simple and efficient method of speed control. The rotor of these sets has separate windings of different electrical characteristics, the high-speed section consisting of a squirrel cage low resistance rotor, the low speed being obtained by a ring rotor of cast iron.

Many refinements have also been made in the present enlarged line of standard riveted frame motors.

A ¼ h.p. a. c. and d. c. and a ½ h.p. d. c. motor have been added to the lne of drawn shell small motors and the mechanical construction has been greatly improved.

A reversing type of polyphase motor with high torque and low armature inertia has been put on the market for all work requiring frequent reversals.

Turbo Generators.

Great advances have been made in the development of horizontal shaft generators; these, for most part, operating at higher speeds than the vertical shaft type of the same capacities that have been built heretofore.

Sixty cycle horizontal shaft generators at speeds of 3600 have been developed in 300 kw., 1000 kw., 1500 kw. and 2000 kw. sizes. There have been developed a sixty-cycle, 7500 kw. 1800 r. p. m., a twenty-five-cycle, 7500 kw. 1500 r. p. m., and a thirty-cycle, 7500 kw. 1800 r. p. m. generator.

In the vertical type generators several 20,000 kw. machines have been built during the past year. Some of these are wound for 6600 volts and are being installed in the Waterside No. 1 plant of the New York Edison Company. One of them has been in successful operation for about one month. They are being placed where reciprocating engine units of 3500 kw. capacity have been in service for ten or eleven years.

Water-Wheel Driven Generators.

A large number of interesting generators of both the horizontal and vertical type have been developed for operation at speeds somewhat higher, and also at the lowest speed heretofore attempted.

The lowest speed generator of either horizontal or vertical type that has ever been built by the General Electric Company is the 9000 kw. three-phase, twenty-five-cycle, 11,000-volt type for the Mississippi Power Company, Keokuk, Iowa. The speed is 57.7 r. p. m., and the weight of each generator complete is over 600,000 lbs. Twelve of these are now on order.

A large number of horizontal shaft generators of ordinary capacities and speeds have been developed during the past year, nearly all of them for sixty-cycle service. The highest speed machine is a fifty-cycle generator rated 7000 kw. at 700 r. p. m. Four of these are being built for the Katsuragava Hydro Electric Power Company, Japan. 13,900 k.v.a. sixty-cycle, three-phase, 4000-volt generators at 200 r. p. m. are being built for the Washington Water Power Company, Spokane, Wash.

G. E. Steam, Air and Water Flow Meters.

Early in the year the indicating type FS-2 boiler meter was placed on the market. By certain modifications the standard recording steam meter is used as a recording water meter. This meter is also being furnished for measuring boiler feed water; in fact for any purpose where water is conveyed in closed pipes or conduits.

To measure and record the rate of flow of air, the type RA recording air flow meter, which is a modification of the recording steam flow meter, has been placed on the market. This instrument has proved very successful in the measurement of compressed air used for manufacturing purposes, driving compressed air machinery, mines, etc. It has also been modified so as to make it suitable for measuring the flow of natural gas. Very recently a flowmeter planimeter, —an instrument for summing up the charts obtained from steam, air and water flow meters— has been placed on the market.

Feeder Regulators.

A contract has recently been closed by the City Electric Company, San Francisco, with the General Electric Company, for one o. r. t.-390-k. v. a. 10,750 volts primary 265 amperes secondary, automatic regulator to be used in conjunction with one w. c. t.-575 k. v. a. 10,750 volts Y-9500 volts Y-auto transformer, for the purpose of tying the Folsom street station of the company with that of the generating station at Oakland. This necessitated the laying of a submarine cable across San Francisco Bay. The scheme as laid out is arranged so that during the greater part of the time the Oakland station will be supplying the power to the City Electric Company, but if emergency arises power can be supplied to the City Electric Company and delivered to the busses of the Oakland station. The combination is to deliver 5200 k. v. a. through the bay cable from Oakland to San Francisco. As the bus voltage in Oakland is 12,000, and that in San Francisco is normally 11,500, the combination of auto transformer and automatic feeder regulator is so arranged that these voltages can be raised or lowered in accordance with the load demand, or can be kept at normal voltage on either bus, depending upon which station is supplying the power.

Another notable installation of General Electric feeder regulators is that of the Great Falls Power Company at the Rainbow station. From the Rainbow station two 150-mile transmission lines run to Butte; also a transmission line of about five miles long to Great Falls and the B. & M. smelter. Since each of these transmission lines to Butte took an exciting current of approximately 6000 k. v. a., it was necessary to hold the station bus bars at 6100 volts in order to have the required 6600 volts at Butte. Also in case of one or both of these transmission lines being suddenly opened, the voltage at the bus bar would fluctuate anywhere from 6100 to 7600 volts. When the busses were operating at 6100 volts the induction motors at Great Falls would run extremely hot because of low voltage. To remedy these defects an automatic three-phase voltage regulator, rated at 800 k. v. a. 6600 volts, was installed in the Great Falls transmission line.

Concrete Core Reactances.

The year 1911 witnessed the development of a new type of current limiting reactance for protecting transformers and turbo generators from the severe mechanical shocks resultant with short circuits. The reactances are intended for connection in series with transformer or feeder lines, or between sections of the bus bars, one for each phase, and are designed to develop with normal line current a voltage drop of from 4 to 10 per cent of line voltage, 6 per cent being considered standard.

On account of the heavy flux caused by these reactances it is necessary to avoid magnetic material in the reactance or its vicinity. The core or supporting structure consists of a hollow concrete pilar, upon the outer cylindrical surface of which are bolted the radial coil supports of rosin-treated wood. The conductor consists of stranded bare cable wound in grooves in the wood supports, which are protected from contact with the cable by heat shields of asbestos. All the metal parts used in the construction are either of brass or non-magnetic alloy.

Transformers.

High voltage self-cooled outdoor transformers have recently been built in capacities of 1000 k. v. a. and 500 k. v. a. for 110,000 volt service, being the highest voltage transformers ever attempted in either the self-cooled or outdoor types.

A notable achievement during the past year was the construction in the Pittsfield works of the General Electric Company of two 500 k. v. a. 750,000 volt testing transformers. One of these transformers is for use in the Pittsfield factory for insulation tests and experiments in high voltage phenomena. The transformer has been operated up to 900,000 volts. At this potential no corona was noticed on the transformer or high-tension leads.

CHANGE IN AGENCY ARRANGEMENTS.

Pierson, Roeding & Company announce that, on January 1, 1912, the existing agency agreement between their company and the Ohio Brass Company, of Mansfield, Ohio, for the sale of O-B Overhead Materials, Rail Bonds and Car Equipment Specialties, will be terminated. Since the early part of 1906, Pierson, Roeding & Company have been the exclusive Pacific Coast agents for all O-B material except Hi-Tension porcelain. During the past two years a separate selling arrangement has been maintained covering the Hi-Tension porcelain specialties manufactured by the Ohio Brass Company. The sale of this material has been in the hands of the Holabird-Reynolds Company of San Francisco who will hereafter also represent the Ohio Brass Company for their Railway Materials in the State of California.

During all this time, and in fact since porcelain insulators came into use, Pierson, Roeding & Company have been the exclusive Pacific Coast Agents for the Locke Insulator Manufacturing Company, handling the well known "Victor" Porcelain, which company they will continue to represent.

By mutual agreement it has been decided that separate agency arrangements for Hi-Tension materials and for O-B electric railway equipment will eventually prove unsatisfactory and that the general business of both companies will be better served by a single agency for these divisions of the O-B product.

Pierson, Roeding & Company bespeak for the new agents, the continued support of customers for the Ohio Brass Company's railway materials, which has been accorded to them in the past.

Announcement regarding Pierson, Roeding & Company's further agency plans will be made at a later date.

WESTINGHOUSE ELECTRIC PROGRESS DURING 1911.

Continuing the summary of development of the Westinghouse Electric & Manufacturing Company during 1911, as published in these columns last week, the development of transformers has not seen any marked innovation. The general tendency trends more and more towards the elimination of transformers requiring auxiliary cooling devices, and the increased use of self-cooled transformers which necessitate no auxiliary devices. This eliminates to a great extent the necessity for expensive and careful attendance. The well known tubular type of transformer, brought out by the Westinghouse company, is used for the larger capacities of the oil insulated, self-cooled types. A number of these large tubular type transformers of various sizes and characteristics have been built.

The outdoor transformer, for voltages higher than those ordinarily used in distribution work, has been brought to such a state of development that it is being used in constantly increasing numbers for all classes of work. While designed for outdoor service, it is but slightly more expensive than that designed for indoor use, and it eliminates expensive building construction. This saving in the first cost of an installation has made many a proposition feasible where means could not be obtained for an installation requiring a building, indoor transformers and switching equipment.

There has been a tendency, though not a decidedly marked one, towards the three-phase transformer rather than the use of three single-phase transformers.

In general, the work of the year has been more for the betterment of the details entering into the design; thus conforming with the specifications.

One rather interesting feature has been the development of a special car for shipment of large transformers complete ready for installation. This method has proven to be the ideal way to ship transformers. It eliminates delay and expense in installation after the transformer is received at destination. With the ordinary type of flat car there is often insufficient head room or clearance on the railroads for the larger transformers, and the special cars which have been built for this particular purpose have made it possible to ship very much larger capacities.

Electric Light Development.

The past year has been marked by numerous improvements in arc and incandescent lamps of a year ago, together with the introduction of new types. The standard line of enclosed carbon arc lamps of the alternating and direct-current types for constant potential and constant current circuits; as well as the direct current series multiple lamp, have continued in large demand notwithstanding the newer types.

The metallic flame arc lamp, using electrodes of a metallic nature, although comparatively new, has attained a breadth of use greatly in excess of previous years. The principle changes in the metallic flame arc lamp have been a reduction in weight, and certain improvements in the design of glass globes for securing the best light distribution.

The most important advance, however, in the arc lamp field has been the introduction of a long-burning, impregnated carbon flaming arc lamp. The carbon flaming arc lamp, with its penetrating yellow light, has been familiar for some time. The chief objection to the old lamp has been the extremely short life of electrodes, but this new lamp, with its high candlepower and the excellent feature of long electrode life, greatly increases the possibilities in the application of carbon flaming lamps.

The combined carbon-filament and tungsten lamp sales during the past year have been notable. While the carbon-filament lamp has maintained substantially the same demand as in former years, the tungsten lamp sales have seen a remarkable increase. The wire type continuous filament tungsten lamp, introduced several years ago, is no longer a venture, but has demonstrated its superiority over older types by its rugged characteristics and long life.

New Motors.

During the past year the Westinghouse company placed on the market two new motors of special interest.

The type SK motor is designed for general power purposes. Its chief characteristics are simplicity of construction, light weight, and excellent commutation under all conditions of load. The motor frame is a rolled steel ring and the feet are pressed steel rivited to the ring. Each motor on the line has commutating poles.

The new Westinghouse direct-current mill motor, type MC, represents the most advanced design in motors for severe intermittent service. It is not only sufficiently strong to withstand the roughest usage of mill service, but every detail is so designed that the cost of maintenance is reduced to a minimum and repairs and renewals, when necessary, can be made with the least loss of time.

THE WESTINGHOUSE MACHINE CO. DEVELOPMENTS DURING 1911.

The past year has witnessed notable achievements in the engineering activities of this company. Chief among these and probably that which has attracted widest attention among engineers has been the development of a successful high-power reduction gear for use with steam turbines. The interesting and distinguishing characteristics of this gear is in the hydraulic support of the pinion frame, by means of which an even distribution of tooth pressures is secured, thus eliminating the question of wear, which has heretofore prevented a more general acceptance of the large geared turbine unit. There are at the present time seven of such units in successful operation, the service comprising direct current generation, marine propulsion and centrifugal pump drive. Undoubtedly its widest use will be in the application of turbine drive to large direct current generators, this being impracticable in the direct connected unit, owing to excessive commutator surface speeds and difficulties attendant thereto.

Turbines.

In turbine work a more general use of the efficient combined type employing low pressure reaction and high pressure impulse blading is to be noted. This has resulted not only in the production of superior economies, but also a more compact and mechanical construction. Reaction or Parsons' blading has been retained in the low pressure and intermediate stages, as it is admittedly the most efficient type in the lower pressure ranges.

The development of the automatic bleeder turbine has been a most important one in its economic solution of the problem existing in central stations or industrial power plants supplying low pressure steam for heating or other requirements in addition to its electrical load.

The feature of the turbine is an automatic valve located between the intermediate and low pressure sections, which diverts steam at the pressure and in the quantity desired to the heating system, the remainder passing through the low pressure and doing useful work.

In the design of the small re-entry type impulse turbine for driving centrifugal pumps and direct current generators progress has been similarly in evidence. A great number of these units varying in capacity from 1 kw. to 300 kw. have been built and found to satisfactorily meet the demands of the service. They are chiefly used as excitation sets or for boiler feeding in large central stations, and frequently as the main units in small isolated plants.

Condensers.

While there have been no material changes introduced in the general design of the Leblanc condenser built by the company, the past year has shown steady advances in the size of units and "turn" type condensers are now in commercial service, having a condensing capacity of 250,000 pounds of steam per hour.

NEWS NOTES

INCORPORATIONS.

VISALIA, CAL.—The Ducor-California Hot Springs Telephone & Telegraph Company have filed articles of incorporation. The capital stock of the company is $10,000, the following directors being named: L. S. Wingrove, Hot Springs; F. M. Carlisle, Ducor; H. F. Brey, Porterville; M. F. Singleton, Ducorñ and J. F. Guthrie, White River. It is declared intention of this company to build and maintain a telephone system between the towns of Hot Springs, Ducor, Terra Bella, Porterville and Rich Grove. The estimated length of the line will be 13 miles.

ILLUMINATION.

VISALIA, CAL.—Exeter's Board of City Trustees has adopted and advertised for sale the franchise sought by the Tulare County Power Company.

ANTIOCH, CAL.—The city authorities of Antioch are contemplating an election in the near future for the establishment of an electric light and power plant.

LOS ANGELES, CAL.—Residents of Hawthorne will soon hold another election for the purpose of petitioning the county supervisors to install 100 more street lights.

PASCO, WASH.—Probably the most important matter to come before the City Council will be the matter of extending the franchise of the Pacific Power & Light Co.

SPOKANE, WASH.—The Inter-Mountain Supply Company, with offices in the Hutton Building, bid $9404 for installing the electroliers against $9803.65 bid by the Washington Water Power Company.

MONTPELIER, IDAHO.—The Telluride Power Company has been awarded a franchise to operate and maintain an electric light and power plant here and same must be in operation within nine months.

FALLON, CAL.—The City Council passed an ordinance authorizing the city of Fallon to construct an electrical lighting, heating and power system to borrow $15,000 for said purpose, and to issue and sell bonds of said city therefor.

EUGENE, ORE.—Extensive improvements of the lighting system by the extension of the lines and the installation of a tungsten system through the residence districts are being planned for by Engineer Alvin Myers, who is in charge of the city lighting plant.

LOS ANGELES, CAL.—Specifications for street lighting for the coming year have been prepared by R. H. Manahan, city electrician, and sent to the Board of Public Works. The board has sent them to the council with a request for authorization to advertise for bids.

HALF MOON BAY, CAL.—An election will be held in the Half Moon Bay Lighting District of San Mateo County, January 13, 1912, for the purpose of voting on the question of installing and maintaining a system of street lights on the public highways of the said district.

ELLENSBURG, WASH.—The City Council has voted to install cluster lights on all the business streets of the city from Third to Fifth and from Main to Pine. The lights have been installed on lower Third street, from the depot to Main street, and have proved highly satisfactory.

GLENDALE, CAL.—The City Clerk will receive sealed bids up to January 8th for furnishing the city with single-phase transforming capacity 5 to 50 kilowatts, induction integrating wattmeters, tungsten and carbon incandescent lamps. Goods must pass inspection by the manager of the Glendale Municipal Lighting Department.

MOXEE CITY, WASH.—The officers of the Moxee City Commercial Club have signed contracts with the Pacific Power & Light Company for electric lighting the village. The power will be stepped down from the high tension line running from North Yakima to Priest Rapids.

REDWOOD CITY, CAL.—Attorney A. Kincaid, in behalf of the Halfmoon Bay Light & Power Company, has presented a petition for a franchise to erect poles and wires in the First Road District. The Clerk has published the notice offering the franchise for sale, bids to be opened at the first meeting in February.

VALLEJO, CAL.—Prof. C. L. Cory, head of the electrical department at the University of California, who had been employed by the city to give an expert opinion on the value of the Vallejo Light & Power Company, has advised the city to pay $115,000 for the plant as it stands. The commissioners will probably submit to the people a bond election for the purchase of the old system as a start for a municipal plant.

MARTINEZ, CAL.—Van E. Britton, a son of John E. Britton, president of the Pacific Gas & Electric Company, has been granted a franchise to lay gas mains along the county roads to connect the towns of Antioch, Pittsburg, Bay Point, Concord and Martinez. The home office of the new gas concern, of which young Britton is the head, is to be situated at the little town of Pittsburg. Franchises to supply gas to the residents of the various towns have already been procured.

TRANSMISSION.

IRONDALE, WASH.—The Olympic Power Company is making preparations for the extension of its transmission line from here to Bremerton, a distance of forty miles.

CLE ELUM, WASH.—The Brown Company of Seattle has been commissioned by the Kittitas Railway & Power Company to make surveys for its new hydroelectric development and electric railway from this city to the Cle Elum mining district, a distance of 40 miles, at a cost of $1,500,000, and also to prepare plans for the construction of light and power plant and mechanical equipment for the mines of the Castle Rock Light, Heat & Power Company, at Castle Rock. About $275,000 is to be expended.

TRANSPORTATION.

SACRAMENTO, CAL.—The bid of the Sacramento Electric, Gas & Railway Company for the annexed territory was accepted and a franchise granted.

ROSSLAND, B. C.—A representative of the Westinghouse Company of Pittsburg has been on the ground figuring on the electrification of the Canadian Pacific Railway between Castelgar and Rossland.

TACOMA, WASH.—The franchise of the Seattle-Tacoma Short Line Company will be extended until January 10, 1914, provided the company will agree to expend at least $20,000 in Pierce county within six months.

WENATCHEE, WASH.—The Wenatchee Valley Railway & Power Company has acquired a franchise over the roads of the Wenatchee valley. It is expected that the line between here and Leavenworth will be in operation next fall.

LOS ANGELES, CAL.—Following the completion of the Van Nuys line, the Pacific Electric will take up the task of broad-gauging the present narrow-gauge line to San Pedro from Gardena. By use of the new Redondo cutoff between Gardena and Los Angeles a second all broad gauge line will be ready for operation from city to the harbor.

CORNING, CAL.—The application of F. S. Risley of Seattle, representing the International Mono-rail Company, has asked for a franchise to enter the city of Corning. The trustees have taken the matter under advisement. The route outside of the towns will be over private rights of way.

PASADENA, CAL.—The City Clerk will receive sealed bids up to January 9th for the purchase of a thirty year franchise for an electric railroad along Washington street, from North Lake avenue to eastern city boundary. After a period of nineteen years the city may acquire the road by condemning or any legal procedure.

OAKLAND, CAL.—Plans are being prepared for the terminal buildings of the Oakland and Antioch Railway, to be erected on the block at Fortieth and Opal streets, and Shafter avenue. Work will begin on the construction of the buildings shortly after the first of the year, and be completed with the completion of the line into Oakland, which will be July 1 of next year.

SEATTLE, WASH.—Bids will be received by the Board of Public Works until 10 a. m. January 12 for the construction of the track of Division A of the municipal electric car line from Stewart street and Third avenue to Salmon Bay. The estimated cost is $80,000. Plans may be had of H. R. Dimock, city engineer. Superintendent of Public Utilities A. L. Valentine reports to the council that 15 cars will be necessary to equip the proposed municipal railway. His report contains a recommendation that single end cars be used.

STOCKTON, CAL.—Andrew McCormick, an extensive cattle and land owner in San Joaquin and the southern mines country for thirty years, has been elected president of the Stockton Terminal and Eastern Railroad. The other officers of the road are F. J. Detrich, vice-president; E. F. Davis, treasurer; Robert F. Burns, secretary, and J. E. Adams, traffic manager. The road is owned by the shareholders of the United Investment Company, which also owns and controls large gravel and macadam rock properties at Jenny Lind.

TELEPHONE AND TELEGRAPH.

GARDNERVILLE, NEV. The United Farmers' Telephone & Telegraph Company has applied for a franchise to construct a telephone and telegraph lines in certain parts of the county of Douglas, State of Nevada. The petition will be heard January 15th.

PASADENA, CAL.—The war between the city and the Pacific Telephone & Telegraph Company, which has occupied the attention of all the courts in the State for many years, has ended with the corporation agreeing to pay $31,030, which the city demanded as a condition precedent to the consideration of a franchise.

WILLOWS, CAL.—At a meeting of the stockholders of the Glenn County Telephone Company a board of directors was elected as follows: Andrew Kaiser of Germantown; George Ellis of Elk Creek; M. Ossinbriggin of Butte City; C. L. Donohoe, and H. J. Barceloux of Willows. The officers are: W. H. Travis, general manager; A. S. Lindstrom, secretary, and H. J. Barceloux, president. The capital stock of the company was doubled. It increased from $100,000 to $200,000. The company is now arranging to enter San Francisco, Oakland, Berkeley and Sacramento over the Postal wire.

TACOMA, WASH.—The Tacoma and Bellingham exchanges of the Home Telephone Company have been consolidated with the Sunset exchanges in the two cities. The Sunset company became actual owner of the Tacoma and Bellingham branches of the Home Telephone Company of Puget Sound on December 21, when the sale at public auction was confirmed by Federal Judge Rudkin. The sum of $483,000 was in the bank to conclude the exchange of monies. The upset price paid 10 days ago was $67,000, the total being $550,000. By energetic work the Sunset company has succeeded in connecting up the 1400 exclusive subscribers to the "Home" system in Tacoma, providing the necessary cables and equipment in the Tacoma office so that the consolidation can go into immediate effect. The automatic instruments will be used, without the automatic features and will be replaced as rapidly as possible with Sunset instruments.

SAN FRANCISCO, CAL.—Confirmation has been given to reports that the Postal Telegraph Company will enter the telephone field. Preparations, it is said, were begun six months ago for this service, by the leasing of wires or agreements for an exchange of traffic with independent companies operating on the Pacific Coast. Radical reductions from present rates are planned, according to Postal officials. From San Francisco to Sacramento the rate will be 25 cents for ten minutes; from San Francisco to Reno, 50 cents for the first minute; from San Francisco to Salt Lake City, $1.50 for five minutes; from Salt Lake to Reno the charge will be $1 for the first minute; from Salt Lake to Sacramento, $1.35. J. G. Blake, general superintendent for the Pacific division of the Postal company, states that the company's plans for telephone service throughout the coast region were rapidly nearing completion and that the service would be inaugurated at an early date. The arrangements made by the Postal company include an exchange of wire traffic with the United States Long Distance Company, operating in Southern California, and with the Santa Barbara Telephone Company, which covers Santa Barbara county. Wires of the Interstate Consolidated Company between Seattle and Spokane have been leased, Postal officials state; also wires of the Home Telephone Company of Southern Oregon between Ashland and Portland.

WATERWORKS.

SUTHERLIN, ORE.—Sutherlin has voted $30,000 bonds for a modern waterworks system.

MORGAN HILL, CAL.—Sealed bids will be received up to December 30, 1911, for the construction of a water system for said town and for iron pipe for same.

POCATELLO, IDAHO.—Preston voted $75,000 bonds for the construction of a municipal water plant; the new system is to include 21 miles of pipe with gravity pressure.

EVERETT, WASH.—The Everett Railway, Light & Water Company's big reservoir will be in service within two months. This new storage basin is designed to hold 10,000,000 gallons.

WAPATO, WASH.—The bid of Fairbanks, Morse & Co., in the sum of $7497 for installing the pumping plant and pump house and reservoirs for the municipal water system, has been accepted.

MADERA, CAL.—Acting on the advice of City Engineer Keays, the City Trustees refuse to accept the new municipal water plant of F. C. Roberts until further tests are made and it is proved beyond doubt that the wells are up to the specifications.

MONMOUTH, ORE.—There were but two bids received for the construction of the Monmouth water system bids. G. Jaeger of Rich Hill, Missouri, will put in the system for $13,150, and Welton, Kibbe & Cochran of Portland, Ore., offers to put it in for $13,880. Bids were laid over until the next regular meeting for consideration.

WILLOWS, CAL.—Fifty thousand dollars has been paid out to property holders of the Newville section for options on property for the dam site and lake site for the great Newville irrigation project. In addition to this, options have been taken on several thousand acres of land along the proposed canal, which will hug the foothill section west of Willows. It is said that water can be used twice for power generating before it passed into the irrigation canals. A party with engineers will be brought to the valley by L. W. Warmoth, the Paskenta promoter of the project, to take a final look at the territory.

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